SCOPE OF WORK

VOLUME 2

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1-1. DESCRIPTION

1-1.01. Definition: The Work is defined per General Conditions Section GC-3.

1-1.02. Alternatives: As presented in the bid schedule.

1-1.03. Summary: Major areas of the Work consist of, but are not limited to, the following items:

The work to be performed under this contract is limited to the ICWRC Decommissioning and SRWRC Primary Clarifiers and Auxiliary Equipment. The facility locations are:

Intrenchment Creek WRC
1510 Key Road, SE
Atlanta, GA 30316

South River WRC
955 South River Industrial Boulevard, SE
Atlanta GA 30315

1-1.04. The work to be done under this contract, the ICWRC Decommissioning and SRWRC Primary Clarifiers and Auxiliary Equipment, includes, but is not necessarily limited to, construction of the following:

1. Two new coarse bar screens at ICWRC.
2. New transfer pump station at ICWRC.
3. New transfer pump station electrical building at ICWRC.
4. Electrical and instrumentation work at ICWRC.
5. Piping connections at ICWRC.
6. Site work at SRWRC.
7. ICWRC additive alternative modification of existing digester to equalization storage.
8. Two new primary clarifiers at SRWRC.
9. New primary headhouse with primary sludge pumps and clarifier drain pumps at SRWRC.
10. New primary scum pumps at SRWRC.
11. New primary junction box and piping connections at SRWRC.

12. Miscellaneous structures at SRWRC.
13. Electrical and instrumentation work at SRWRC.
14. Piping connections at SRWRC.
15. Site work at SRWRC.
16. SRWRC additive alternative of a third primary clarifier.

1-1.05. The work to be done under this contract, the ICWRC Decommissioning and SRWRC Primary Clarifiers and Auxiliary Equipment, Phase I, also includes modifications/demolition as follows:

1. Demolition of Digester 1 cover and associated digester piping at ICWRC (in additive alternate).
2. Demolition of parts of trickling filter No. 1 and 2 at ICWRC.
3. Demolition of two coarse bar screens at ICWRC.
4. Demolition associated with the transfer pump station and site piping at ICWRC.
5. Demolition of acetic acid system at SRWRC.
6. Demolition of gravity thickeners at SRWRC.
7. Demolition of thickener control building at SRWRC.
8. Demolition of digester complex (digesters 1-3) at SRWRC.
9. Demolition of DAF facility and polymer building at SRWRC.

1-2. INTERIM MILESTONES, SUBSTANTIAL COMPLETION AND FINAL COMPLETION DATES

1-2.01. Milestone 1: 180 days after NTP – Complete demolition at ICWRC. Work includes excavation and site work, and construction of and retaining wall.

1-2.02. Milestone 2: 330 days after NTP – Complete demolition and site preparation at SRWRC. Work includes addition of a temporary ferric chloride feed facility, and demolition of the old Digester Complex, DAF Facility and Polymer Building, old Thickener Control Building, Gravity Thickeners, Acetic Acid system, Chemical Feed/Maintenance Building, excavation and site work, and construction of base roads and retaining walls.

1-2.03. Milestone 3: 690 days after NTP – Substantially complete new work at SRWRC. Work includes two new primary clarifiers, new primary headhouse with primary sludge pumps and clarifier drain pumps, new primary scum pumps, new primary junction box and piping connections, new chemical building, SRWRC additive alternative for new primary clarifier No. 3 and electrical and instrumentation work at SRWRC.

1-2.04. Milestone 4: 912 days after NTP – Substantially complete new work at ICWRC. Work includes new coarse bar screens, new transfer pump station, ICWRC additive

alternative for EQ storage, piping connections, new electrical building, and electrical and instrumentation work at ICWRC.

1-2.05. Milestone 5: 1032 days after NTP – Final completion and clean-up of all work.

End of Section

SECTION 01014

WORK SEQUENCE

PART 1 - GENERAL

1-1. SCOPE.

1-1.01. Work under this Section includes construction sequencing and provision of temporary facilities necessary to maintain the efficiency of the wastewater treatment facilities and to prevent wastewater bypasses and basement flooding during the performance of this Work.

1-1.02. The existing wastewater treatment plants are currently and continuously receiving and treating sewage, and those functions shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of plant equipment and processes. The Contractor shall comply with the following general requirements:

Provide temporary pumps and other facilities necessary to meet the requirements of this Section.

Notify the Engineer at least 48 hours prior to starting to relocate piping or taking existing components out of service.

Bypassing of untreated or partially treated sewage to surface waters or drainage courses is prohibited during construction. In the event accidental bypassing is caused by the Contractor's operations, the City shall immediately be entitled to employ others to stop the bypassing without giving written notice to the Contractor.

1-1.03. Penalties imposed on the City as a result of any bypass caused by the actions of the Contractor, his employees, or subcontractors, shall be borne in full by the Contractor, including legal fees and other expenses to the City resulting directly or indirectly from the bypass.

1-2. SUBMITTALS.

1-2.01. In accordance with the General Conditions, the Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment or structure from service.

The schedule shall be coordinated with the construction schedule specified in the Special Conditions and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for preventing

bypassing of other treatment units, the length of time required to complete said operation, the necessary plant, and equipment which the Contractor shall provide in order to prevent bypassing of associated treatment units.

1-2.02. Sequence Submittal: The sequence provided in Part 3 of this Section is offered as a suggestion to the Contractor. Submit a proposed sequence with appropriate times of starting and completion of tasks to Engineer for review.

1-2.03. Alternate Sequences: Contractor may propose alternate sequences to that shown in Part 3 of this Section in an attempt to reduce the disruption of the operation of the existing facility or streamline the tasks of this Contract.

1-3. QUALITY ASSURANCE.

1-3.01. At least two weeks prior to any proposed activity which will require any portion of the plant to be removed from operation, require bypassing or require interruption of plant flow, the Contractor shall schedule a meeting with Plant Operating Personnel and the Engineer. At this meeting, the Contractor shall present Contractor's detailed plan for the proposed operation for general discussion. The plan shall meet the minimum requirements below:

Plan shall be written in outline form and presented in a format which shall show the progression of events in sequential and/or concurrent order of activity and the duration of each activity.

The written plan shall be supplemented by drawings, sketches, and details as required to show the logic of the plan and make it understandable.

The plan shall delineate the responsibilities of the Plant Operating Personnel and the Contractor, so as to eliminate any delay due to conflicting viewpoints upon implementation of the plan.

After discussion of the plan at the meeting, any changes agreed upon shall be incorporated into the plan and a copy of the plan and details shall be distributed to Plant Operating Personnel, the Engineer, and Contractor personnel at least one week prior to commencement of activities. On the day prior to commencement of activity a brief meeting of involved parties shall be convened. In this meeting the starting time and initial activity of Plant Operating Personnel and Contractor's personnel shall be agreed upon.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3-1. GENERAL. The sequence of construction is outlined for the major items of Work required; no attempt has been made to describe every detail of the Project. The Contractor shall coordinate his work with the Plant Operating Personnel to minimize disruptions in plant operation. It shall be the Contractor's responsibility to insure that all existing facilities are protected and will not be damaged as a result of this construction. No settlement of existing facilities will be acceptable and all work shall be performed in a safe manner.

3-2. PROPOSED CONSTRUCTION SEQUENCE. The project shall be constructed in six stages which will permit continuous operation of the facilities and provide treatment of wastewater to a quality equivalent to the existing secondary treatment plant or better at all times. The six stages of construction shall generally be performed in sequence, with overlap as required to maintain the treatment facilities in service. The six stages proposed are:

Step 1 - Mobilization and Preparation
Step 2 - Demolition
Step 3 - Clearing and Excavation
Step 4 - Construction of Improvements
Step 5 - Start-up and Testing of Improvements
Step 6 - Cleanup and Final Restoration

3-3. REQUIRED SEQUENCES. The following items define the order of certain construction steps which must occur in order to properly and safely operate and maintain the treatment facilities. The work will include activities at two separate locations.

3-3.01. Intrenchment Creek Water Reclamation Center (ICWRC)

1. Demolition of parts of trickiling filters No. 1 and 2 and excavation for new transfer pump station.
2. Demoliton of existing bar screens and replacement, one train at a time. The west bar screen shall be demolished and replaced first. Flow shall be continued to flow through the east bar screen, while demolishing the west bar screen. Once the west bar screen (SCRA-20) is installed and operational, the contractor shall divert flow to the new bar screen while installing the east bar screen (SCRA-10).
3. Pending award of ICWRC additive alternative No. 1, demolition of digester cover and associated piping, and cleaning and rehabilitation of alternative EQ storage tank.
4. Installation of transfer pumps and associated piping at the transfer pump station, and influent and effluent connections.
5. Installation of new electrical building and power to transfer pumps and associated equipment.

6. Installation of associated yard piping from headworks to transfer pump station and from existing transfer pump station to the new transfer pump station.
7. Complete rehabilitation headworks, transfer pump station, and influent and effluent connections.
8. Installation of concrete bulkheads at existing headworks.
9. Start-up and testing of headworks, transfer pump station, and make connections to influent and effluent lines
10. Begin operation of new coarse screens at the existing headworks, and using transfer pump station to new primaries at SRWRC – **items 3-3.02.6 below <u>must</u> be completed prior to this activity**.

3-3.02. South River Water Reclamation Center (SRWRC)

1. Rehabilitate the existing Ferric Chloride feed system
2. Demolish Old Digester Complex (Digesters 1-3), DAF Facility and Polymer Building, Thickener Control Building, Gravity Thickeners, Acedic Acid system
3. Begin construction of new Collection/Primary Clarifier Splitter Box, Primary Clarifiers, Primary Sludge Pump Station (Headhouse) and Scum Pump Stations
4. Complete construction of Collection/Primary Clarifier Splitter Box, Primary Clarifiers, Primary Sludge Pump Station (Headhouse) and Scum Pump Stations
5. Start-up and testing of new Primary Clarifiers, Primary Sludge Pump Station (Headhouse) and Scum Pump Stations
6. Begin operation of new Primary Clarifiers, Primary Sludge Pump Station (Headhouse) Scum Pump Stations

3-4. <u>COORDINATION WITH OTHER CONTRACTORS</u>. The performance of the project shall be coordinated with other work going on at the same time on the project site. Certain portions of the project are required to be completed so that others can perform their work in a timely manner. The construction schedule prepared by the Contractor shall take in account the intermediate requirements depicted on the sequence diagram included.

3-5. <u>LIMITS OF CONSTRUCTION</u>. Due to the requirement for other contractors to be performing work on the site, Contractor's access to the site may be limited. The Contractor shall have access to some areas of the site only during certain steps during construction. The Contractor shall have access to the property defined within the construction limits throughout the project. Additionally, he shall have access to areas within the construction limit of others for only the periods of time required to perform the work. The areas available for access by the Contractor during the five steps of the project are shown on the Contractor Site Access drawings for each step included in this specification.

3-5.01. Except where indicated otherwise on the drawings, all pipeline and underground construction shall terminate at the construction limit lines indicated on the drawings. The Contractor reaching the construction limit first shall be responsible for adequately capping the line to both allow for testing and for easy continuation of or connection to the line by the Contractor continuing the line.

3-5.02. The Contractor shall be responsible for performing work within the construction limits of other contractors. The work to be performed within the construction limits of other contractors includes:

1. Rehabilitation of Existing Digester under Energy Performance Contract
2. Rehabilitation of UV System under Energy Perfomance Contract

3-6. MISCELLANEOUS CONSTRUCTION. Miscellaneous work necessary to complete any flow diversion required may include piping, electrical work, diversion plugs, bulkheads, and equipment installation, etc. The cost for these items shall be included in the Contractor's base bid.

3-7. OPERATION OF EXISTING FACILITIES. The City will pay all costs for power and chemicals which are required to operate the existing plant during any flow diversion.

End of Section

SECTION 01040

COORDINATION

PART 1 - GENERAL

1-1. SUMMARY.

1-1.01. Coordinate execution of the Work with subcontractors and the Engineer as required to maintain operation of the existing facilities and satisfactory progress of the Work.

1-1.02. Requirements of this Section will be in addition to those stated in the General Conditions.

1-1.03. The Engineer may require a written explanation of the Contractor's plan for accomplishing separate phases of the Work.

1-2. CUTTING AND PATCHING.

1-2.01. The Contractor shall leave all chases or openings for the installation of its own or any of its subcontractor's work, or shall cut the same in existing work, and shall see that all sleeves or forms are at the work and properly set in ample time to prevent delays. See that all such chases, openings and sleeves are located accurately and are of proper size and shape, and shall consult with the Engineer and its subcontractors concerned in reference to this work. In case of its failure to leave or cut all such openings or have all such sleeves provided and set in proper time, the Contractor shall cut them or set them afterwards at its own expense, but in so doing shall confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall structural members be cut without the written consent of the Engineer.

1-2.02. Carefully fit around, close up, repair, patch, and point around the work specified herein to the satisfaction of the Engineer.

1-2.03. All of this work shall be done by careful workers competent to do such work and with the proper small hand tools. Power tools shall not be used except where, in the opinion of the Engineer, the type of tool proposed can be used without damage to any work or structures and without inconvenience or interference with the operation of any facilities. The Engineer's concurrence with the type of tools shall not in any way relieve or diminish the responsibility of the Contractor for such damage, inconvenience, or interference resulting from the use of such tools.

1-2.04. Do not cut or alter the work of any subcontractor, except with the written consent

of the subcontractor whose work is to be cut or altered, or with the written consent of the Engineer. All cutting and patching or repairing made necessary by the negligence, carelessness or incompetence of the Contractor or any of its subcontractors, shall be done by, or at the expense of, the Contractor and shall be the responsibility of the Contractor.

1-3. EXISTING UTILITIES.

1-3.01. Consult with the Engineer on a daily basis while the Contractor is performing demolition, excavation, or any other alteration activity. No sewer function, utility or structure is to be altered, shut off or removed unless approved in advance, and in writing, by the Engineer. The Contractor shall give the Engineer at least 48 hours advanced notice, in writing, of the need to alter, shut off or remove such function.

1-3.02. Coordinate the Work with the Engineer and revise daily activities if needed so as to not adversely affect system operations. Such revisions in the proposed work schedule will be accomplished with no additional compensation to the Contractor.

End of Section

SECTION 01045

CUTTING AND PATCHING

PART 1 – GENERAL

1-1. DEFINITIONS

1-1.01. Definition: "Cutting and patching" includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting and patching required to restore surfaces to their original condition.

Cutting and patching is performed for coordination of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.

Cutting and patching performed during the manufacture of products, or during the initial fabrication, erection or installation processes is not considered to be "cutting and patching" under this definition. Drilling of holes to install fasteners and similar operations are also not considered to be "cutting and patching".

"Demolition" and "Selective Demolition" are recognized as related- but-separate categories of work, which may or may not require cutting and patching as defined in this section; refer to "Demolition" and "Selective Demolition" sections of Division 2.

1-1.02. Refer to other sections of these specifications for specific cutting and patching requirements and limitations applicable to individual units of work.

Unless otherwise specified, requirements of this section apply to mechanical and electrical work. Refer to Division-15 and Division-16 sections for additional requirements and limitations on cutting and patching of mechanical and electrical work

1-2. SECTION INCLUDES

1-2.01. This Section specifies administrative and procedural requirements for cutting and patching.

1-2.02. Refer to other sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

Requirements of this Section apply to mechanical and electrical installations. Refer to Division-15 and Division 16 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

1-3. RELATED SECTIONS

1-3.01. Drawings and general provisions of Contract, including; general and Supplementary Conditions and other Division-1 Specification Sections, apply to this section.

1-3.02. Demolition of selected portions of the building for alterations is included in Section "Selective Demolition".

1-4. QUALITY ASSURANCE

1-4.01. Requirements for Structural Work. Do not cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio.

Obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety related systems:

a. Primary operational systems and equipment.
b. Air or smoke barriers.
c. Water, moisture, or vapor barriers.
d. Fire Protection Systems.
e. Control Systems.
f. Communication systems.
g. Conveying systems
h. Noise and vibration control elements and systems.

1-4.02. Operational and Safety Limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance, or decrease operational life or safety.

1-4.03. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in the Architect's opinion, reduce the building aesthetic qualities, or result in visual evidence of cutting and patching. Remove and replace Work cut and patched in visually unsatisfactory manner.

If possible, retain the original installer or fabricator to cut and patch the exposed Work listed below. If it is impossible to engage the original installer or fabricator, engage another recognized experienced and specialized firm.

a. Stonework and stone masonry.
b. Window wall systems.
c. Ornamental metal.
d. Firestopping
e. Stucco and ornamental plaster.

f. Carpeting.
g. Wall Coverings.

1-4.04. Before cutting and patching the following categories of work, obtain approval to proceed.

Structural steel.

Miscellaneous structural metals, including lintels, equipment supports, stair systems and similar categories of work.

a. Structural concrete.
b. Foundation construction.
c. Steel.
d. Lintels.
e. Bearing and retaining walls.
f. Structural decking.
g. Exterior curtain wall construction.
h. Equipment Supports.
i. Piping, ductwork, vessels and equipment.
j. Structural systems of special construction, as specified by Division-13 sections.
k. Shoring, bracing, and sheeting.
l. Primary operational systems and equipment.
m. Water/moisture/vapor/air/smoke barriers, membranes and flashings.
n. Noise and vibration control elements and systems.
o. Control, communication, conveying, and electrical wiring systems.

1-4.05. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

1-4.06. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1-5. SUBMITTALS

1-5.01. Procedural Proposal for Cutting and Patching: Where prior approval of cutting and patching is required, submit proposed procedures for this work well in advance of the time work will be performed and request approval to proceed. Include the following information, as applicable, in the submittal:
Describe nature of the work and how it is to be performed, indicating why cutting and patching cannot be avoided. Describe anticipated results of the work in terms of changes to existing work, including structural, operational and visual changes as well as other significant elements.

List products to be used and firms including their qualifications that will perform work.

Give dates when work is expected to be performed.

List utilities that will be disturbed or otherwise be affected by work, including those that will be relocated and those that will be out-of-service temporarily. Indicate how long utility service will be disrupted.

Approval by the Architect to proceed with cutting and patching does not waive the Architect's right to later require complete removal and replacement of unsatisfactory work.

When cutting and patching of structural work involves the addition of reinforcement, submit details and engineering calculations to show how that reinforcement is integrated with original structure to satisfy requirements.

1-6. WARRANTY

1-6.01. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

PART 2 - PRODUCTS

2-1. MATERIALS

2-1.01. General: Except as otherwise indicated, or as directed by the Contracting Officer, use materials for cutting and patching that are identical to existing materials. If identical materials are not available, or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

The use of a trade name and suppliers name and address is to indicate a possible source of the product. Products of the same type from other sources shall not be excluded provided they possess like physical and functional characteristics.

2-1.02. Use materials that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3-1. EXAMINATION

3-1.01. Before cutting existing surfaces examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered.

3-1.02. Before cutting, examine the surfaces to be cut and patched and the conditions under which the work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding with the work.

3-1.03. Before the start of cutting work, meet at the work site with all parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict between the various trades. Coordinate layout of the work and resolve potential conflicts before proceeding with the work

3-2. PREPARATION

3-2.01. Temporary Support: Provide temporary support of Work to be cut.

3-2.02. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

3-2.03. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

3-2.04. Take precautions necessary to avoid cutting existing pipe conduit, or ductwork serving the building, but schedule to be removed or relocated until provisions have been made to bypass them.

3-3. PERFORMANCE

3-3.01. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.

3-3.02. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original conditions.

3-3.03. Cut existing construction using methods least likely to damage elements retained or adjoining construction. Where possible, review proposed procedures with the original installer; comply with the original installer's recommendations.

In general, where cutting is required, use hand or small tools designed for sawing or grinding, no hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

To avoid marring existing finish surfaces, cut the exposed or finished side into concealed surfaces.

Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.

Comply with requirements of applicable Sections or Division-2 where cutting and patching require excavating and backfilling.

By-pass utility services such as pipe or conduit, before cutting, where services are shown or required to be removed, relocated or abandoned. Cut-off pipe or conduit in walls or partitions to be removed. Cap valve or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

3-3.04. Patching: Patch with durable seams that are as invisible a possible. Comply with specified tolerances.

Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

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.

When removal of walls or partitions extends one finish area into another, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, as necessary to achieve uniform color and appearance.

Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken area containing the patch, after the patched area has received primer and second coat.

Patch, repair or rehang existing ceiling as necessary to provide an even surface of uniform appearance.

3-4. CLEANING

3-4.01. Thoroughly clean areas and spaces where cutting and patching is performed or used as access. Completely remove paint, mortar, oils, putty, and items of similar nature. Thoroughly clean piping, conduit and similar features before paint or other finishing is applied. Restore damaged pipe covering to its original conditions.

3-4.02. Do not permit traffic over unprotected floor surface.

End of Section

SECTION 01060

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1-1. SCOPE.

1-1.01. Permits and Responsibilities: The Contractor shall, without additional expense to the City, be responsible for obtaining NPDES permits for stormwater discharges from this project, and for complying with any applicable federal, state, county and municipal laws, codes and regulations, in connection with the prosecution of the Work.

For South River WRC, City of Atlanta and Fulton County have jurisdiction on all municipal and county permits respectively.

For Intrenchment Creek WRC, DeKalb County, not COA, has jurisdiction on local site, tree removal/replacement and fire review permitting. Jurisdiction for permits for road work will be COA if within City limits and DeKalb County if outside City limits. All other local permitting will be thru the COA. The water service to the Intrenchment Creek WRC is a COA utility. Although DeKalb County has jurisdiction, COA site development of civil drawings will be required anyway for the Contractor to secure the COA building permit.

The Contractor shall, without additional expense to the City, be responsible for obtaining all building permits, and for complying with any applicable federal, state, county and municipal laws, codes and regulations, in connection with the prosecution of the Work. Work may include, but not be limited to:

a. COA Building permits
b. COA and DeKalb Fire review permits
c. COA and DeKalb Public utility permit
d. COA Water service permit
e. COA Urban design Commission approval

The Contractor shall, without additional expense to the City, be responsible for obtaining and paying for all site development permits and fees, and for complying with any applicable federal, state, county and municipal laws, codes and regulations, in connection with the prosecution of the Work. Work may include, but not be limited to:

f. COA and DeKalb Land disturbance permits
g. COA and DeKalb Site development permits
h. COA and DeKalb Arborist permits

The Contractor shall, without additional expense to the City, be responsible for obtaining all electrical, HVAC, and plumbing permits, and for complying with any applicable

federal, state, county and municipal laws, codes and regulations, in connection with the prosecution of the Work. Work may include, but not be limited to:

i. COA Electrical permits
j. COA Mechanical/HVAC permits
k. COA Plumbing permits
l. COA Fire sprinkler permits
m. COA Temporary power permits

The Contractor shall, without additional expense to the City, be responsible for obtaining all demolition permits, and for complying with any applicable federal, state, county and municipal laws, codes and regulations, in connection with the prosecution of the Work. Work may include, but not be limited to:

n. Required submittal for demolition permits
o. Rodent inspection for buildings to be demolished
p. Rodent letter from extermination company
q. Hauling permit

The Contractor shall, without additional expense to the City, be responsible for obtaining all railroad permits, and for complying with any applicable federal, state, county and municipal laws, codes and regulations, in connection with the prosecution of the Work. Work may include, but not be limited to:

r. Norfolk Southern crossing or occupancy permit

1-1.02. The Contractor shall take proper safety and health precautions to protect the Work, the workers, the public and the property of others.

1-1.03. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the Work, except for any completed unit of construction thereof which may heretofore have been accepted.

1-1.04. Separate permits will be required for the Intrenchment Creek WRC site and for the South River WRC site.

1-1.05. Permit Fees: The Contractor must be prepared to pay for ALL permit fees, and must include these fees in their bid. A limited list of permit fees expected, from the City of Atlanta, Office of Buildings, is shown below – **this is not a complete list of permit fees, and does not include fees from other City of Atlanta departments and from DeKalb County**. The Contractor must verify these fees, as they are subject to change.

Fee Type	Base Fee	Technology Fee	Minimum Permit Fee Amount
Building Permit Fees	$150	$25	$175
	$7 per $1,000 of cost of construction (applies to entire contract amount including allowances)		

Electrical Permit	$150	$25	$175
Mechanical / HVAC Permit	$150	$25	$175
Plumbing Permit	$150	$25	$175
Temporary Power Permit	$150	$25	$175
Public Utility Permit	$150	$25	$175

1-1.06. City of Atlanta, Office of Buildings contact for building-related permits: Ms. Mary A. Miller, (404) 330-6691, or mamiller@atlantaga.gov.

1-2. NPDES PERMITS FOR STORM WATER DISCHARGES.

1-2.01. The Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)), as amended in 1987, requires National Pollutant Discharge Elimination System (NPDES) permits for storm water discharges associated with industrial activity.

1-2.02. On November 16, 1990, (55 FR 47990), the Environmental Protection Agency (EPA) issued regulations establishing permit application requirements for storm water discharges associated with industrial activity. These regulations are primarily contained in Section 122.26 of Section 40 of the Code of Federal Regulations (40 CFR Part 122.26).

1-2.03. The November 16, 1990 regulation established the following definition of "storm water discharge associated with industrial activity" at 40 CFR 122.26(b)(14):

> "Storm water discharge associated with industrial activity" means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. For the categories of industries identified in subparagraphs (i) through (x) of this subsection, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:
>
> (ix) and (xi) omitted for brevity.

(x) Construction activity including clearing, grading and excavation activities except: Operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale.

1-2.04. These regulations are effective for all activities covered by the regulation on or after October 1, 1992.

1-2.05. As a minimum, the Contractor shall complete EPA Form 3510-2F. A manual entitled "Guidance Manual for the Preparation of NPDES Permit Applications for Storm Water Discharges Associated With Industrial Activity" as published by the United States Environmental Protection Agency, is available to assist the Contractor in the application process.

End of Section

Section 01070

ABBREVIATIONS OF TERMS AND ORGANIZATIONS

1. LIST OF ABBREVIATIONS. Abbreviations for standards and organizations used in the Contract Documents are defined as follows:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies
AFBMA	Antifriction Bearing Manufacturers Association now recognized as the ABMA
AFPA	American Forest & Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHRI	Air-Conditioning, Heating and Refrigeration Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Movement and Control Association International
ANSI	American National Standards Institute
APA	Engineered Wood Association (formerly American Plywood Association)
API	American Petroleum Institute
AREMA	American Railway Engineers and Maintenance-of-Way Association
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	ASTM International
AWG	American Wire Gauge
AWI	Architectural Woodwork Institute
AWPA	American Wood-Preservers' Association
AWS	American Welding Society

AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America (formerly SCPI)
CDA	Copper Development Association
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRA	California Redwood Association
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standard (U.S. Department of Commerce)
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EEI	Edison Electric Institute
EJCDC	Engineers' Joint Contract Documents Committee
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
Fed Spec	Federal Specification
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FM	Factory Mutual
FSA	Fluid Sealing Association
HEI	Heat Exchange Institute
HMI	Hoist Manufacturers Institute
HPMA	Hardwood Plywood Manufacturers Association
HTI	Hand Tools Institute
I-B-R	Institute of Boiler and Radiator Manufacturers
IEEE	Institute of Electrical and Electronics Engineers
IBC	International Building Code
IES	Illuminating Engineering Society
IFI	Industrial Fasteners Institute
IPCEA	Insulated Power Cable Engineers Association
IRI	Industrial Risk Insurers
ISA	International Society of Automation
LEED	Leadership in Energy and Environmental Design
MHI	Materials Handling Institute
MIL	Military Specification
MMA	Monorail Manufacturers Association
MSS	Manufacturers Standardization Society of Valve and Fitting Industry
NAAMM	National Association of Architectural Metals Manufacturers
NACE	NACE International
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors

NBS	See NIST
NCSPA	National Corrugated Steel Pipe Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEII	National Elevator Industry, Inc.
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology (formerly NBS)
NLA	National Lime Association
NPC	National Plumbing Code
NPT	National Pipe Thread
NRMCA	National Ready Mixed Concrete Association
NSC	National Safety Council
NSF	NSF International (formerly National Sanitation Foundation)
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PS	Product Standard
RIS	Redwood Inspection Service
SAE	SAE International
SDI	Steel Door Institute
SFPA	Southern Forest Products Association
SI	Systéme International des Unités (International System of Units)
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricators Association
SPI	Society of the Plastics Industry
SPTA	Southern Pressure Treaters Association
SSFI	Scaffolding, Shoring & Forming Institute, Inc
SSPC	SSPC: The Society for Protective Coatings
TABB	Testing, Adjusting, and Balancing Bureau
UL	Underwriters' Laboratories
USBR	U.S. Bureau of Reclamation
USGBC	U.S. Green Building Council
WEF	Water Environment Federation

End of Section

SECTION 01100

SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1-1. CONNECTIONS TO EXISTING SYSTEMS.

1-1.01. The Contractor shall perform all work necessary to locate, excavate, and prepare for connections to the terminus of the existing systems as shown on the Drawings. The cost for this work and for the actual connection to the existing systems shall be included in the bid price for the project and shall not result in any additional cost to the City. Connections shall be made only after approval by the Engineer.

1-2. RELOCATIONS.

1-2.01. The Contractor shall be responsible for the relocation of structures, including but not limited to light poles, signs, sign poles, fences, piping, conduits, and drains that interfere with the positioning of the Work as set out on the Drawings. The cost of all such relocations shall be included in the bid price.

1-3. EXISTING UNDERGROUND PIPING, STRUCTURES, AND UTILITIES.

1-3.01. The attention of the Contractor is drawn to the fact that during excavation, the possibility exits of the Contractor encountering various water, gas, telephone, electrical, or other utility lines not showed on the Drawings. The Contractor shall exercise extreme care before and during excavation to locate and flag these lines so as to avoid damage to the existing lines. Should damage occur to an existing line, the Contractor shall repair the line at no cost to the City.

1-3.02. The locations of existing underground piping structures and utilities are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent a true picture of underground piping to be encountered.

1-3.03. The existing piping and utilities that interfere with new construction shall be rerouted as shown, specified, or required. Before any piping and utilities not shown on the Drawings are disturbed, the Contractor shall notify the Engineer of the location of the pipeline or utility and shall reroute or relocate the pipeline or utility as directed.

1-3.04. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities, which do not interfere with complete work, shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor

shall be restored or replaced by the Contractor at its expense as directed by the Engineer.

1-4. HAZARDOUS LOCATIONS.

1-4.01. The existing wet wells, manholes and related areas are hazardous locations, in that explosive concentrations of sewage gas may be present. The Contractor is cautioned that the above areas, especially the wet well, may be deficient in oxygen. Checks shall be made by the Contractor whenever personnel are working in these areas to determine if adequate oxygen is available.

1-5. CONNECTIONS TO WORK BY OTHERS.

1-5.01. As shown on the Drawings, pipelines constructed under this Contract are to be connected to pipelines to be built by others.

1-5.02. Pipelines built under this Contract will be connected to pipelines constructed by others by removing the plugs and making the connection.

1-5.03. If the pipelines have not been constructed by others, the pipeline (under this Contract) shall be laid to the required line and grade, terminated with a plugged connection, precisely at the location indicated on the Drawings and then backfilled and marked with a stake.

1-6. WATER FOR CONSTRUCTION PURPOSES.

1-6.01. All water for testing, flushing and construction shall be furnished by the City. The City shall have the option of recouping the cost of plant water usage. It may be available by connecting to the City's water system at a point approved by the Engineer. There shall be installed in each and every connection to the City's potable water supply, a meter and a backflow preventer meeting the requirements of the City of Atlanta, Department of Water.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01200

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1-1. SCOPE.

1-1.01. Work includes furnishing all plant, labor, equipment, tools, materials, and performing all operations required to complete the Work satisfactorily, in-place, as specified and as indicated on the Drawings.

1-1.02. All costs of required items of work and incidentals necessary for the satisfactory completion of the Work shall be considered as included in the Total Bid. The cost of work not directly covered by the pay items shall be considered incidental to the contract and no additional compensation shall be allowed.

1-1.03. The Contractor shall take no advantage of any apparent error or omission on the Drawings or Specifications, and the Engineer shall be permitted to make corrections and interpretations as may be deemed necessary for fulfillment of the intent of the Contract Documents.

1-2. SUBMITTALS.

1-2.01. Contractor shall submit to the Engineer for approval, in the form directed or acceptable to the Engineer, a complete schedule of values of the various portions of the Work, including quantities and unit prices, aggregating the Contract Price. An unbalanced breakdown providing for overpayment to the Contractor on items of Work, which would be performed first, will not be approved.

1-2.02. Submit application for payment on a form approved by the Engineer showing allowances, lump sum schedule of value items, and unit price items in accordance with Section SC-16.

1-2.03. Final payment quantities shall be determined from the record drawings. The record drawing lengths, dimensions, quantities, etc. shall be determined by a survey after completion of all required work. The precision of final payment quantities shall match the precision shown for that item in the Bid Schedule.

1-3. LUMP SUM ITEM.

1-3.01. Payment of the lump sum items established in the Contractor's Bid shall be full compensation for all labor, materials, and equipment required to furnish, install, construct,

and test the Work covered under the lump sum bid item.

1-3.02. Payment of the lump sum items established in the Contractor's Bid shall also fully compensate the Contractor for any other work which is not specified or shown, but which is necessary to complete the Work.

1-3.03. The lump sum item shall be specifically subdivided by Activity, broken-out in the Schedule of Values.

1-3.04. Payments for the lump sum items specifically broken-out in the Schedule of Values will be based upon physical progress for each activity in accordance with the breakdown of the Lump Sum prices agreed to in the Schedule of Values.

1-3.05. All work to complete the Project, and which is not included in all other Items, shall be included in the lump sum amount. The bid shall also include demolition and proper disposal of removed materials and equipment, mobilization and demobilization, and all costs associated with start-up, testing, training and manufacturers services for the start of operations of the improvements.

1-4. UNIT PRICE ITEMS.

1-4.01. Payment for all work shall be in accordance with the unit price bid items in the Bid Schedule and shall be full compensation for all labor, materials, and equipment required to furnish, install, construct, and test the Work covered under the unit price bid item. Work for which there is no price schedule item will be considered incidental to the Work and no additional compensation shall be allowed.

1-4.02. Payment will be made only for the actual quantities of work performed in compliance with the Drawings and Specifications. The Contractor will be paid an amount equal to the approved quantity times applicable unit price. Any unused balance of the unit price work shall revert to the City upon completion of the project.

1-4.03. All unit price work shall be considered as part of the Work to be performed within the time limits specified elsewhere for Substantial Completion and Project Completion. No increase in contract time will be allowed for increases in quantities of unit price work performed beyond the quantities shown in the Bid Schedule, unless it can be demonstrated that the additional Work performed under the unit price item is on the critical path of the Project Schedule.

1-5. BASE BID.

1-5.01. Demolition and removal of existing utilities and abandoned treatment structures at the South River WRC as shown on the drawings.

1-5.02. Furnishing all products, materials and equipment, and performing all labor necessary to complete and put into operation one (1) new covered junction box at the South River WRC as shown on the drawings and specifications of this document.

1-5.03. Furnishing all products, materials and equipment, and performing all labor necessary to complete and put into operation two (2) new primary clarifiers at the South River WRC as shown on the drawings and specifications of this document.

1-5.04. Furnishing all products, materials and equipment, and performing all labor necessary to complete and put into operation one (1) new headhouse with primary sludge pumping, primary scum pumping and drain pumps at the South River WRC as shown on the drawings and specifications of this document.

1-5.05. Upgrades to the existing ferric chloride system at the South River WRC as shown on the drawings. These upgrades include the replacement of the existing ferric chloride pumps, improvements of the existing HVAC system, replacement of the existing plant water piping and electrical and instrumentation work associated to these improvements as shown on the Drawings.

1-5.06. Demolition and removal of existing utilities and abandoned treatment structures at the Intrenchment Creek WRC as shown on the drawings.

1-5.07. Furnishing all products, materials and equipment, and performing all labor necessary to complete and put into operation one (1) new transfer pump station at the Intrenchment Creek WRC as shown on the drawings and specifications of this document. This pump station will be provided with transfer pumps to South River and dedicated pumps to the storage tanks at Intrenchment Creek WRC.

1-5.08. Modifications to the existing headworks to install new coarse screens at the Intrenchment Creek WRC as shown on the drawings and specifications of this document. Each channel shall be provided with coarse bar screens with 0.5-inch openings and retrofitted for the existing channels.

1-6. ADDITIVE ALTERNATIVES.

1-6.01. Furnishing all products, materials and equipment, and performing all labor necessary to complete and put into operation one (1) new primary clarifier with the associated sludge pumping and grinder at the South River WRC. This will be in addition to the two clarifiers in the bid base.

1-6.02. A new precast retaining wall instead of cast in place at South River WRC as shown on the Drawings. This alternative will be considered as a deductive to the Project.

1-6.03. Modifications to existing digester to be used as storage of raw sewage at the

Intrenchment Creek WRC. This includes cleaning and disposal of sludge in this digester; removal and disposal of the digester cover, removal and disposal of any mixing equipment inside digester tank and any minor structural rehabilitation for this tank.

1-6.04. Replacement to six electrical actuators. Two actuators are located on the influent and effluent valves on the existing valves. Four actuators are located on the isolation gates upstream and downstream of the screens. Actuators shall be replaced in like kind.

1-7. ALLOWANCES.

1-7.01 Upgrades to the existing DCS Electrical and Instrumentation System at the South River WRC as shown on the drawings and specifications of this document.

1-7.02 Upgrades to the existing DCS Electrical and Instrumentation System at the Intrenchment Creek WRC as shown on the drawings and specifications of this document.

1-7.03 Owner's Allowance for Unforeseen Work Elements and Utility Conflicts: An allowance has been established as the value of this item. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of additional work, where the cost amounts are determined as specified in General Condition Article GC-42.3 for Force Account Work. This work, not shown or specified in the Drawings and Specifications bid by the Contractor and not covered by another item in the Bid Schedule, may be required in the event the Engineer establishes the need for additional work deemed to be necessary for the successful completion of this contract, or in the event utilities not shown in the Drawings are encountered and impact the contract related work.

End of Section

Section 01310

CONSTRUCTION PROGRESS SCHEDULE

PART 1 – GENERAL

1-1. GENERAL OVERVIEW. A Progress Schedule shall be used to control the Work and to provide a definitive basis for determining project progress. The Progress Schedule shall be prepared, maintained and updated by the Contractor and historical dates agreed monthly with the Engineer. The Contractor shall submit a preliminary Progress Schedule and a Progress Schedule for acceptance by the Engineer. These schedules shall be the Contractor's working schedules and shall be used to plan, organize and execute the Work, record and report actual performance and progress, and show how the Contractor plans to complete all remaining Work as of the end of each progress report period.

The Progress Schedule shall comprise all the detailed construction-related activities using the critical path method (CPM). The Progress Schedule shall provide sufficient detail and clarity to reflect the intricacies and interdependencies of activities so the Contractor can plan, schedule, monitor, control and report on the progress of his work. In addition, it shall provide the Engineer and City a tool to monitor and follow the progress for all phases of the Work.

1-2. PRE-CONSTRUCTION SCHEDULING CONFERENCE. The Engineer will conduct a pre-construction scheduling conference with the Contractor to review requirements for the schedules including Schedule of Values and schedule configuration. The conference shall be conducted sufficiently early to allow the Contractor to submit the preliminary Progress Schedule within ten days of the Effective Date of the Agreement.

At this meeting, the Contractor shall explain in detail the procedure to be used to develop the schedule activity cost-loading or Schedule of Values and cash flow. This procedure is subject to the review and acceptance of the Engineer.

1-3. PRELIMINARY PROGRESS SCHEDULE. Following the pre-construction scheduling conference but within ten calendar days of the Effective Date of the Agreement, the Contractor shall submit a preliminary Progress Schedule for review by the Engineer. The preliminary Progress Schedule shall show detailed construction-related activities for the first 30 days of the project. The remainder of the Contract activities shall be shown as summary bars within the Milestones of the Work. If the Engineer has comments on the preliminary Progress Schedule, Contractor shall make the necessary changes and resubmit it within ten calendar days. No progress

payments will be made during the period specified above for the preliminary Progress Schedule until the preliminary Progress Schedule has been accepted by the Engineer. The preliminary Progress Schedule shall:

a. Illustrate a feasible schedule for completion of the Work within the time and Milestones specified.

b. Provide an elementary example of the schedule in the format to be used for the Progress Schedule.

c. Include the activity code structure as described in paragraph 19 of this specification.

1-3.01. Preliminary Progress Schedule Submittal Format: Contractor shall submit two compact disks of the preliminary Progress Schedule. Compact disks shall be read-write and enable the use of the schedule as an executable file as described herein. A brief narrative shall accompany the submittal, describing Contractor's scheduling approach to the project. The narrative shall include a description of the Contract Milestones, approach for construction activities during the period of the preliminary Progress Schedule, description of the general approach of the activities for the work beyond the preliminary Progress Schedule period, a description of the project's critical path, identification of critical long-lead submittals, and planned outages. The narrative shall also incorporate activity codes, calendars, weather days, Milestone constraints, and work breakdown structure in accordance with the requirements specified herein.

1-4. PROGRESS SCHEDULE .The Progress Schedule comprises all the construction-related activities for the Work and shall show the order in which the Contractor proposes to carry out the work. Contractor shall include Milestones, coordination necessitated by limited access and available work areas, and the availability and use of manpower, material and equipment. Contractor shall use the Progress Schedule to plan, schedule and coordinate the Work including activities of subcontractors, equipment vendors, and suppliers.

The Progress Schedule shall be to the level of detail acceptable to the Engineer, and shall include the following:

a. Organization and structural breakdown of the Project;

b. Milestones and completion dates;

c. Type of work to be performed and the labor trades involved;

d. Purchase, manufacture and delivery activities for major materials and equipment;e. Preparation, submittal, and acceptance of shop drawings and material samples;

f. Deliveries of owner-furnished equipment and/or materials;

g. Acceptances required by regulatory agencies and/or other third parties;

h. Assignment of responsibility for each activity;

i. Access requirements to work areas;

j. Identification of interfaces and dependencies with preceding, concurrent and follow-on Contractors;

k. Tests, submittal of test reports and acceptance of test results;

l. Planning for phased or total acceptance by City; including start up and commissioning;

m. Identification of any manpower, material and equipment restrictions.

n. Sequence of construction to maintain plant operations;

o. Planned outages.

The activities included in the Progress Schedule shall be defined in work days. Durations shall be based on the labor (crafts), equipment, and materials required to perform each activity on a normal workday basis. Activity durations shall be 20 working days or less except in the case of non-construction activities such as procurement of materials, delivery of equipment, and concrete curing. All durations shall be the result of definitive manpower and resource planning by Contractor to perform the Work, in consideration of contractually defined on-site work conditions and Contractor's planned means and methods.

When the Progress Schedule is accepted by the Engineer, the Engineer will save a copy of the Progress Schedule as the baseline schedule, and will use it for analysis of Contractor's progress.

The Contractor shall update the Progress Schedule monthly.

1-5. ELECTRONIC PROGRESS SCHEDULE FORMAT AND REPORTING. The Progress Schedule shall be created using Primavera P6 scheduling software. Contractor shall use Engineer's file-naming format throughout the project.

a. Electronic schedule files shall be saved with .XML or .XER file extensions.

b. Primavera Project Manager settings for “Baseline Type” shall be used in the following manner:

   i. Select <None> as the baseline type for the Preliminary Schedule Submittal.

   ii. Once the Preliminary and Project Schedule are accepted, the baseline type shall be named <Initial Plan>.

   iii. Each subsequent Project Schedule update shall set the baseline type to <Last Performance Update>.

c. The data date for schedule calculation in the preliminary Progress Schedule and Progress Schedule shall be set as the date of the Notice to Proceed unless otherwise specified by the Engineer.

1-6. COST-LOADING. Except for manufacturer lead-time, each Progress Schedule activity that has an actual cost shall have a cost value assigned to it. Equipment or material delivery activities bearing cost shall be separate activities. Each activity’s assigned cost shall consist of all costs associated with that activity including all project management, superintendence, overhead and profit costs. The sum of all activity costs shall be equal to the current Contract value at all times, including approved change orders. The Contractor shall certify that the costs are not unbalanced and that the value assigned to each activity represents the Contractor’s total cost to perform that activity.

If the Engineer or City determines cost data does not meet the requirements for a balanced bid breakdown, the Contractor shall submit documentation substantiating any cost allocation questioned. Cost allocations will be considered unbalanced if activity on the Progress Schedule has been assigned a disproportionate allocation of direct costs, overhead and profit. If documentation of the cost data does not, in the opinion of the Engineer substantiate cost allocations, the Progress Schedule will be returned to the Contractor for action.

Unit Price items required to be paid on a unit cost basis as identified in the Bid Form and the Measurement and Payment section shall be incorporated into the Progress Schedule and measured and updated as specified herein and as specified in the Measurement and Payment section.

The Contractor shall produce Cash Flow Projection reports and graphics from the Primavera P6 application.

Cost-loaded data shall be the basis for monthly payment applications and shall be included with monthly updates of the Progress Schedule.

1-7. RESOURCE-LOADING. Not used.

1-8. COORDINATING PROGRESS SCHEDULE WITH OTHER CONTRACT SCHEDULES. Where work is to be performed under this Contract concurrently with or contingent upon work performed on the same facilities or area under other contracts, the Progress Schedule shall be coordinated with the schedules of the other contracts. City will provide the schedules of other contracts for preparation and updating of the Progress Schedule. Contractor shall revise the Progress Schedule as required by changes in schedules of other contracts.

In case of interference between the operations of different Contractors, the City will determine the work priority of each Contractor and the sequence of work necessary to expedite the completion of the entire project. In all such cases, the decision of City shall be accepted as final.

1-9. SUBMITTALS. The Progress Schedule and associated reports shall be submitted to the Engineer for acceptance within the period of the preliminary Progress Schedule specified herein. If the Progress Schedule is not submitted, no progress payments will be made after the due date until the Progress Schedule has been submitted.

Printouts and electronic layouts required as part of the Progress Schedule submittal and monthly updates are as follows:

a. Summary Schedule: one page milestone and summary schedule, sorted by total float, early-start, early-finish;

b. Detailed Project Schedule: organized by Work Breakdown Structure (WBS) or area of work; sorted by total float, early-start, early-finish;

c. Critical Path Schedule: sorted based on the total float, early-start, early-finish;

d. 60-Day Look Ahead Schedule: sorted by total float, early-start, early-finish;

e. Activities in Progress: organized by WBS or area of work; sorted by total float, early-start, early-finish;

f. Cash Flow Trending Report: presented in an S-Curve format based on original planned early start and late start forecasted expenditures. In addition, the historical actual data point(s) are to be graphed within the S-Curve graphic report;

g. Monthly payment projections;

h. Out-of-sequence Report: tabular report showing work performed out-of-sequence.

Contractor shall submit additional layouts if directed by Engineer.

The submittal shall include the following:

Narrative report summarizing the contract milestones, critical path, project approach including phasing or use of crews, significant submittal and fabrication items, coordination or interface requirements, City-provided items, and list of subcontractors and vendors.

Graphic reports including critical path report (longest path), summary schedule report, total float report by early-start early-finish, look-ahead report grouped by work breakdown structure or project phasing, and cash flow projection. Cash flow projections include estimated cumulative cost curves based on early and late start dates and projection of monthly payments over the life of the project

The schedule, critical path, and look-ahead schedules shall be submitted on E (34”x44”) size paper or 36” wide plots;
The Progress Schedule file shall be submitted in an executable format, using Primavera Project Manager (P6) format on a read-write compact disk.

The narrative and graphic reports shall be provided on 8”x11” paper and E-size plots respectively.

Contractor shall submit 4 copies of each deliverable.

1-10. MONTHLY SCHEDULE UPDATES. Monthly Progress Schedule updates shall be submitted for the duration of the Contract on a date agreed to by the City, Engineer, and Contractor. If monthly Progress Schedule updates are not submitted by the due date, progress payments will be withheld until the required information is submitted.

The updated schedule shall be reviewed each month in a meeting with Engineer to verify:

a. Actual start dates,

b. Actual completion dates,

c. Activity percent completion,

d. Revised logic (as-built and projected) and changes in activity durations, cost assigned,

e. Cost influence of change orders, if any,

f. Revisions due to extension of time.

Prior to each meeting, Contractor shall prepare a complete and accurate report of current procurement and construction progress through the end of the update period, and a depiction of how Contractor plans to continue the Work to meet all contract completion dates. All network changes and status data agreed to during each update meeting shall be considered as accepted by both parties unless written notice of any exceptions is given within five calendar days after the meeting.

For major network changes that cannot be agreed to during an updating meeting, Contractor shall submit the proposed changes for Engineer's acceptance prior to inserting such changes into the network. Submittals may be in the form of marked-up networks, fragnets, or schedule abstracts, provided they are submitted with a letter of transmittal. A fragnet is defined as a sequence of new activities and/or activity revisions that are proposed to be added to the existing schedule to demonstrate how project events have an impact on the schedule.

1-11. DATA DATE. The data date is the re-settable date in P6 that serves as the end of a reporting period. The reporting period will be recorded on a monthly basis, e.g., January 1st through January 31st with the 31st as the data date. If required for coordination purposes by the City, the Engineer will provide specific data dates to be used by the Contractor.

1-12. REVIEW PROCESS. Engineer will review Contractor's preliminary Progress Schedule and full Progress Schedule submittals within 15 calendar days after receipt of all required information.

At the request of City or Engineer, Contractor shall participate in any meetings necessary to reach a mutual agreement and acceptance of the preliminary Progress Schedule, Progress Schedules, or Cash Flow Projections.

If any of the required submittals are returned to Contractor for corrections or revisions, they shall be resubmitted within ten calendar days after the return mailing date. Resubmittals shall include all information and media included in the first submittal. Review and response by Engineer will be given within 10 calendar days after receipt of each resubmittal.

Schedules shall show contract completion of the Work on the Contract completion date and with zero or positive total float even if the Contractor plans to finish early. In no

event shall acceptance of the schedule be a basis for a claim for delay against City or Engineer by Contractor for an early finish. A Progress Schedule containing activities with negative float or that extend beyond the Contract completion date will not be acceptable.

Acceptance of the Progress Schedule by Engineer does not relieve Contractor of responsibility for accomplishing the Work by the Contract completion date. Omissions and errors in the accepted Progress Schedule shall not relieve the Contractor of obligations under the Contract. Acceptance by Engineer in no way makes Engineer or City an ensurer of the Schedule's success or liable for time or cost overruns. Engineer and City hereby disclaim any obligation or liability by reason of acceptance of the Progress Schedule by the Engineer.

1-13. RESPONSIBILITY FOR SCHEDULE COMPLIANCE. Whenever it becomes apparent from the current Progress Schedule that the critical path is delayed and the contract completion date will not be met, Contractor shall mitigate the delay by taking some or all of the following actions at no additional cost to City.

a. Increase construction manpower in such quantities and crafts as will bring the project back on schedule within the completion dates and milestones.

b. Increase the number of working hours per shift, shifts per day, working days per week, and the amount of construction equipment, or any combination of the foregoing, to substantially eliminate the backlog of work.

c. Re-schedule activities to achieve maximum practical concurrence of activities and to comply with the schedule date(s).

Within ten calendar days of the Engineer’s request, Contractor shall submit a recovery schedule and written statement of the steps intended to remove or arrest the delay to the critical path in the schedule. If the Contractor fails to submit the required information or should fail to take measures acceptable to the Engineer, the Engineer with City concurrence may direct Contractor to increase man-power, equipment and scheduled work hours to remove or arrest the delay to the critical path and the Contractor shall promptly provide such level of effort at no additional cost to City.

In the event Contractor fails to follow the updated or revised recovery schedule, City may elect to withhold progress payments until Contractor complies with the revised schedule.

Should Contractor’s efforts not remove or arrest the delay to the critical path of the accepted schedule, then City shall be entitled to supplement Contractor’s work-force and equipment to remove and arrest any delay, and shall be entitled to deduct all costs

and expenses associated therewith from payments due to the Contractor. If insufficient Contract funds remain, City may recover such funds from Contractor and its Surety.

1-14. CHANGE ORDERS, DELAYS, AND EXTENSIONS OF TIME. When change orders or delays are experienced by Contractor and Contractor requests an extension of time, Contractor shall submit a written time impact analysis to the Engineer illustrating the influence of each change or delay to the current Contract Schedule completion date. Each time impact analysis shall include a fragnet incorporating the change order or delay into the Progress Schedule to demonstrate how Contractor was delayed.

Each time impact analysis shall demonstrate the estimated time impact based on the events of the change or the delay; the date the change was given to Contractor or the delay incurred, the status of construction at that point in time, and the event time computation of all activities affected by the change or delay. The event times used in the analysis shall be those included in the latest update of the Progress Schedule or as adjusted for the events of delay.

Three copies of the time impact analysis and an electronic copy on compact disk shall be submitted within seven calendar days of delay occurrence or direction to proceed with a change is given to Contractor. No time extensions will be considered if the time impact analysis is not submitted within the specified time.

The Engineer will review Contractor's time impact analysis. Contractor shall furnish such justification and supporting evidence as the Engineer deems necessary to determine whether Contractor is entitled to an extension of time. Engineer's review of each time impact analysis will be made within 5 working days of receipt of the time impact analysis and additional information as required by the Engineer, unless subsequent meetings and negotiations are necessary.

The Contract completion time will be adjusted only for causes specified in paragraph 15. Time extensions will be granted only to the extent that equitable time adjustments for the activity or activities affected exceed the total or remaining float along the critical path at the time of actual delay. Delays in activities which are not on the critical path and do not affect Contract completion dates, will not be considered for an extension of time.

1-15. CAUSES FOR EXTENSIONS OF TIME. Additional positive total float in the Progress Schedule generated by efficiencies of City or Contractor is a shared commodity to be reasonably used by either party, and belongs exclusively to the Project. The Contractor is not entitled to any additional compensation for completion of the project prior to expiration of the Contract Times.

1-15.01. City-Initiated Changes. City initiated changes to the Contract work that absorb float time will not be considered for an extension of time. City-initiated changes that affect the critical path of the Progress Schedule shall be grounds for extending or

shortening completion dates. Use of float time for Contractor initiated changes will require City's concurrence. Contractor's changes, however, shall give way to City-initiated changes competing for the same float time.

1-15.02. Outside Contractor's Control. Events outside of the Contractor's control that affect the critical path of the Progress Schedule will be considered for an extension or reduction of the Contract Times.

1-15.03. Weather Delays. Engineer will obtain weather data during construction from a reputable source, and will maintain weather records.

Engineer will determine Contractor's entitlement to an extension of the Contract time as a result of weather delays, the data included in Tables 1 and 2. Extensions of time will be granted at the discretion of the Engineer for circumstances not covered by the flow chart.

Any weather-related extension of Contract time shall be non-compensable. Efficiencies gained as a result of favorable weather within a calendar month, where the number of days of normally anticipated weather days is less than expected, shall contribute to the project float and shall not affect the Contract Times.

Application for a weather related extension of time shall be submitted to the Engineer, and shall state the extension requested and be supported by the relevant weather data.

Table 1
Average Monthly Precipitation
(inches)
1996 – 2014
NOAA

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.20	4.67	4.81	3.36	3.67	3.95	5.27	3.90	4.47	3.41	4.10	3.90

Table 2
Average Number of Calendar Days
with Precipitation of 0.50 Inches
or More in a Single 24-hour Period
1883 – 2013
NOAA

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.8	3.2	3.3	2.3	2.7	2.7	3.3	2.6	2.7	2.5	2.7	2.8

1-16. AS-BUILT SCHEDULE. As a condition precedent to release of final payment, the last update to the Progress Schedule submitted shall be identified by the Contractor as the “As-Built Schedule”. The “As-Built Schedule” shall reflect the exact manner in which the project was actually constructed (including actual start and completion dates, activities, sequences, and logic) and shall be signed and certified by the Contractor’s project manager.

1-17. SCHEDULING SOFTWARE APPLICATION. Scheduling software shall be Primavera Project Manager (P6) without exception.

1-18. SCHEDULE SOFTWARE SETTINGS AND RESTRICTIONS: Contractor shall consult with Engineer for acceptable Primavera Project Manager software settings and restrictions. The following shall apply unless otherwise directed by the Engineer.

Schedule Options:

i. Shall be defined only to “Use expected finish dates”;

ii. Scheduling progressed activities to be set to “Use only retained logic”, not progress override option;

iii. Critical Path activities defined as Total Float less than or equal to zero;

iv. Calculating start-to-start lag from “early start” dates; and computing total float as “finish float = late finish – early finish”;

v. Calendar to be set for scheduling relationship lag as “Predecessor Activity Calendar.”

Activity progress shall be shown using Remaining Duration. Date format shall be DDMMYY.

Default activity type shall be set to “Independent Task”.

Date/time activity constraint(s), other than those required by the Contract, will not be allowed unless accepted by Engineer. Contractor shall identify proposed constraints and explain the constraint purpose in the Narrative Report.

Lags shall not be used in the creation of an activity that will perform the same function, e.g., concrete cure time. Lag durations contained in the project schedule shall not have a negative value. Contractor shall identify any lag proposed and explain the purpose of the lag in the Narrative Report.

Actual Start and Finish dates shall not be automatically updated by default mechanism that may be included in the CPM scheduling software system. Actual Start and Actual Finish dates on the CPM schedule shall be updated by actual work progression.

1-19. ACTIVITY CODES. The Primavera (P6) activity codes and work breakdown structure (WBS) to be confirmed or revised by the Engineer are listed below. Confirmation or revision of the activity codes and WBS will be provided to the Contractor within three workdays of the Effective Date of the Agreement. Use of the Engineer prescribed activity codes and WBS is mandatory.

"Project Codes" as defined by Primavera P6 is reserved for the City. Only "Activity Codes" at Project Level will be permitted for Contractor use.

Activity Code	Code Value	Description
Phase	0005	Construction Phase
Construction Phase	A	Milestones
	BC	Administrative
	D	Submittals
	E	Construction Activities
		Closeout Phase
Submittals	SUB	Submittals
	R&A	Review & Approve
	F&D	Fabricate & Deliver
Other Codes to be prescribed by Engineer or requested by Contractor for project specific criteria.		

1-20. ACTIVITY RELATIONSHIPS. Relationships between activities shall be identified with the following information:

a. Predecessor and successor activity ID.

b. Relationship types:

i. FS - Finish to start

ii. SS - Start to start

iii. FF - Finish to finish

iv. SF - Start to finish – This relationship is not allowed, unless authorized by Engineer.

1-21. PROJECT CALENDARS. Project Calendars shall use workdays and calendar days as the planning unit for the schedule. Use of Global Calendars is reserved for City. Each calendar shall be set to start on Mondays with holidays in accordance with City policy. The following calendars shall be used for each activity except as otherwise accepted by Engineer:

5-Day x 8 Hour Workweek (with holidays) shall be used for 5-day 40-hour workweek activities: Monday through Friday. All holidays and non-work days shall be assigned to this calendar. This calendar shall be used for all normal work activities, submittals, and fabricate and delivery activities. This calendar shall be the default calendar for the project unless otherwise specified.

5-Day x 10-Hour Workweek (with holidays) shall be used for 5-day 50-hour workweek activities: Monday through Friday. All holidays and non-work days shall be assigned to this calendar.

6-Day x 10-Hour Workweek (with holidays) shall be used for 6-day 60-hour workweek activities. Monday through Saturday. All holiday and non-work days shall be assigned to this calendar.

7-Day Calendar (no holidays) shall be used for 7-day workweek activities. No non-work days shall be entered into this calendar.

Additional Calendars may be assigned depending on need. However, Contractor shall consult with the Engineer before other calendars are entered and/or used in the Project schedule.

The work day to calendar day correlation shall be based on a single shift and 5-day work week with adequate allowance for holidays, adverse weather and all other special requirements of the Work. Contractor may, at his option, propose alternate baseline calendars to allow a second shift and/or a single shift on Saturdays subject to the concurrence and acceptance of City. Under no circumstances will a schedule be accepted which allows regularly scheduled work on Sundays.

The holidays observed by the City are as follows:

New Years Day
Memorial Day

July 4th
Labor Day
Thanksgiving Day
Christmas Day

1-22. FLOAT. Contractor shall not use float suppression techniques, including preferential sequencing (arranging critical path through activities more susceptible to City caused delay); lag logic restraints; zero total or free float constraints; extended activity times; or imposing constraint dates other than as required by the Contract. Float suppression will be cause for rejection of the preliminary Progress Schedule or full Progress Schedule and its updates.

1-23. MANDATORY MILESTONES. The Contract duration shall be equal to the time period between the Notice to Proceed and the completion Milestone. The following milestones are mandatory.

a. Project Award

b. Notice to Proceed

c. Substantial Completion as established in the Bid Form

d. Completion as established in the Bid Form

The following additional milestones are to be considered and incorporated into the Progress Schedule in accordance with the Contract terms, if applicable.

a. Permit constraints

b. Facility shut down or outage milestone requirements

c. Applicable phasing milestones

d. Other milestones deemed appropriate by the Engineer

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

End of Section

Section 01320

CONSTRUCTION VIDEOS AND PHOTOGRAPHS

SECTION 1 – GENERAL

1-1. SCOPE.

1-1.01. The Contractor shall furnish all equipment, labor, and materials required to provide the Owner with digital construction videos and photographs of the Project.

1-1.02. Photo and video files shall become the property of the Owner and none of the videos or photographs shall be published without express permission of the Owner.

1-2. PRE- AND POST-CONSTRUCTION VIDEOS AND PHOTOGRAPHS.

1-2.01. Prior to the beginning of any work, the Contractor shall take videos and photographs of the work area to record existing conditions. One hundred (100) photographs of the entire site (ICWRC and SRWRC), or pertinent features thereof, shall be taken before the commencement of Work and promptly submitted to Engineer.

1-2.02. Following completion of the work, another set of videos and photographs shall be made showing the same areas and features as in the pre-construction videos and photographs.

1-2.03. All conditions which might later be subject to disagreement shall be shown in sufficient detail to provide a basis for decisions.

1-3. PROGRESS VIDEOS AND PHOTOGRAPHS.

1-3.01. Progress videos and photographs shall include the date and time marking of the recording.

1-3.02. A minimum of twenty-five (25) videos/photographs shall be submitted with each request for payment. The view selections will be as approved by the Engineer.

1-3.03. Contractor to provide aerial photographs for both ICWRC and SRWRC at 50-percent construction completion and at 100-percent construction completion. Each set of aerial photographs will include north, south, east, and west views of both plants.

1-4. FILE FORMAT, MEDIA AND SUBMITTALS.

1-4.01. Photographs shall be in “jpg” format.

1-4.02. Videos shall be in a format viewable by Microsoft Windows Media Player or Apple QuickTime Player. Audio narration is desirable.

1-4.03. Files shall be named such that what is being viewed is self-evident.

1-4.04. Files shall be submitted on a compact disk (CD) or a digital video disk (DVD). If submitted on DVD, disk shall be recorded in “Minus R” format.

1-4.05. The pre-construction videos and photographs shall be submitted to the Engineer within twenty-five (25) calendar days after the date of receipt by the Contractor of Notice to Proceed. Post-construction videos and photographs shall be provided prior to final acceptance of the Project.

1-4.06. Construction photographs shall be submitted with each payment request. Failure to include photographs may be cause for rejection of the payment request.

SECTION 2 – PRODUCTS (NOT USED)

SECTION 3 – EXECUTION (NOT USED)

End of Section

SECTION 01350

PROJECT DOCUMENT TRACKING AND CONTROL SYSTEM

PART 1 – GENERAL

1-1. SCOPE.

1-1.01. The Contractor shall utilize the City of Atlanta's Project Document Tracking and Control System (DTCS). The primary function of the system is to facilitate timely processing and approval of all contract documentation in coordination with the overall Project Schedule established by these Specifications and the Contractor. This system will utilize e-Builder Enterprise™ for document tracking and control and Lynx Photo Management software. The e-Builder Enterprise™ software will:

1. Facilitate communication among the Owner, Engineer and Contractor;

2. Facilitate turn-around time with regard to responses and approvals;

3. Provide a central location for all Project information to facilitate all Project participants in performing their tasks based on the latest Project data;

4. Provide a standard system of project administration with accountability.

1-1.02. The Contractor shall be required to utilize the web-based DTCS system that resides on the Department of Watershed Management server to generate documents in the proper format for submission to the City. The Contractor shall access the system through the internet using a compatible web browser from the Contractor's administrative field office location, and/or other locations where work associated with the Project is being performed.

1-1.03. The Contractor shall be required to generate Project documents and records utilizing the aforementioned system. The Contractor shall be required to transmit and submit the Project documents within the system to the City.

1-1.04. The Contractor shall utilize a high capacity scanner capable of scanning 11 x 17 documents, double sided, on site for the entire duration of the Project. All documents must be scanned in and attached to the appropriate Contract Manager document, including submittals, shop drawings, O&M's and all other documents requested by the Engineer.

1-1.05. The Contractor shall utilize the DTCS to create and maintain Project documents, including, but not limited to the following:

1. Company Directory: Addresses, Phone Numbers, Personnel Contacts, etc.
2. Drawings Log: Current Drawing revision log

3. Submittals (Integrated with Project Schedule through Activity codes)
4. Transmittals
5. Requests for Information and Answers (RFIs)
6. Change Documents, Including:

    a. Requests for Proposal (RFPs)
    b. Work Authorizations (WAs)
    c. Change Order Requests (CORs)
    d. Change Orders (CO)

7. Daily Reports (Daily Diaries)
8. Field Decisions & Clarification Memos
9. Notice of Non-Compliance
10. Construction Issue Memos
11. Punchlists
12. Meeting Minutes & Agendas
13. Correspondence
14. Work Plans
15. Start-up Plans
16. Equipment Operation and Maintenance Training
17. Spare Parts

1-1.06. The Contractor shall utilize the complete capabilities of the DTCS to meet the requirements of this Section. The Contractor shall provide a highly trained and experienced construction project controls person knowledgeable in construction work sequencing, productivity, scheduling and application of the e-Builder Enterprise™ software system. This person, along with the Contractor's management team, shall work closely with the City to deliver the documents outlined in this Section

1-1.07. Software Support. The Contractor is to provide for a one day training class in the base bid for the Lynx PM software for ten personnel, seven for City of Atlanta and three for the Contractor. Type of class to be determined by the City. The Contractor may contact Lynx PM Representative at 1-877-955-7711.

The Contractor shall be required to establish an internet connection using DSL or better to connect to the DTCS to permit the forwarding and receipt of documents.

a. The e-Builder Enterprise™ software supports the following Email programs, and the Contractor is to utilize:
    (1) Microsoft Outlook 2007
    (2) Microsoft Outlook 2010

The Contractor shall also provide 2 days of consulting services in the base bid for troubleshooting and maintenance of the DTCS at any location designated by the City or at the Contractor's administrative field office (if authorized by the City).

Troubleshooting, maintenance, upgrade, configuration, and set up shall be performed by an authorized representative based on a scope pre-defined by the City of Atlanta. The Contractor shall utilize the custom data fields, dictionaries, and coding systems as required by the City of Atlanta.

1-1.08. The Contractor shall be required to attend a 2-day training session on the operation of the City's DTCS, provided by a e-Builder Enterprise™ Authorized Trainer. The Contractor shall provide the training session for ten participants (fee for the e-Builder Enterprise™ Authorized Trainer). The training session shall be attended by the Contractor (limited to three participants) as well as representatives of the Owner (seven participants). The Contractor shall be responsible for the cost of training for additional members of their firm or future retraining, as may be deemed necessary by the Contractor.

1-1.09. The Contractor shall meet with the City within 15 days after the Contract is awarded to discuss access requirements and the Contractor's plan to utilize DTCS and execute the document control functions herein.

1-1.10. Access through the internet to the DTCS shall be operational within 30 days following the pre-construction meeting date. This must be operational from the contractor's administrative field office location.

1-2. COMPANY DIRECTORY.

1-2.01. The Contractor and the City will monitor and manage the Company Directory. The directory must include Company name, Company abbreviation, contact names, address, phone numbers and e-mail addresses.

1-3. DRAWING LOG.

1-3.01. The City will maintain a log of initial "issued for construction" drawings in the DTCS. Information shall include drawing number, title and revision number. In addition to logging the initial project drawing list, the City will maintain a log on the DTCS of all subsequent revisions to these drawings and any sketches resulting from clarification memos, RFIs, field orders and Change Orders. It is the Contractor's responsibility to utilize the latest drawings and sketches in the performance of the work.

1-4. SUBMITTALS/SHOP DRAWINGS.

1-4.01. Requirements: This section specifies supplemental requirements to GC-28, related to the processing of submittals and shop drawings. The Contractor will utilize the DTCS to log and track submittals, as well as generate associated transmittal letters.

1-4.02. Submittals & Product Data: A list of all required submittals will be entered into the DTCS by the Contractor. Submittals shall be incorporated into packages, with numbering as follows: XXXXX-YYY, where X denotes the applicable specification section; Y denotes the individual submittal number for that particular specification section, beginning with 001.The Contractor will log and track all submittals utilizing the DTCS. Each review cycle shall be entered into the DTCS. The Contractor shall identify as activities in the CPM schedule, specified in SC-16, to include all data submittals, as well as those involving complex reviews and long lead deliveries, and all procurement items required for construction activities. Submittal schedule information shall be updated monthly with the Contractor's updated project CPM schedule, as specified in SC-16.

1-4.03. Samples: A list of all required sample submittals will be entered into the DTCS by the Contractor. Sample submittals shall be identified as individual submittals within the submittal packages with numbering as specified above.

1-4.04. Guarantees/Warranties: A list of all required Guarantee/Warranty submittals will be entered into the DTCS by the Contractor. These submittals shall be identified as individual submittals within the submittal packages with numbering as specified above.

1-4.05. Work Plans, Start-up Plans, O&M Submittals and Spare Parts: All testing, Start-up and O&M submittals will be entered into the DTCS by the Contractor. These submittals shall be identified as individual submittals within the submittal packages identified with numbering as specified above.

1-4.06. Submittal Procedures: The Contractor shall prepare all submittal packages utilizing the submittal numbering system, description and packaging conventions described above. Submittals prepared by the Contractor, which fail to follow the conventions described above, will be returned "amend and resubmit". Should the Contractor determine that a submittal is required and is not covered by the listing within the DTCS, consultation with the City to determine the submittal number, description and packaging will be required.

1-5. CORRESPONDENCE.

1-5.01. The City shall monitor and manage the correspondence, Non-Compliance Notices, Field Decisions & Clarification Memos and Construction Issue Memo logs. The Contractor is responsible for generating Project correspondence within the DTCS, and forwarding the correspondence to the City.

1-6. TRANSMITTAL LOG.

1-6.01. The Contractor and the City will monitor and manage the transmittal log. All Project transmittals shall be created electronically, automatically sequentially numbered and logged into the DTCS system as they are created. The Contractor is responsible

for utilizing the system to create transmittals for items transmitted to the Owner, Engineer, Resident Inspection Staff and other Contractors.

1-7. REQUEST FOR INFORMATION & ANSWERS.

1-7.01. The Contractor shall be responsible for generating RFIs on the DTCS system. The Contractor shall notify the City when an RFI is submitted. The City will monitor and manage the RFI log. The City will generate an Answer document in response to each RFI and forward them to the Contractor. The DTCS will track "Ball in Court" for all RFIs and Answers, as well as date of original generation and response date. In addition the RFIs will reference the relative Specification Section and Drawings. The DTCS will identify the date of the request and the originator, responsible party for a response and the date of the response.

1-8. CHANGE DOCUMENTS.

1-8.01. Change documents include Request for Proposals (RFPs), Work Authorization Requests (WARs), Work Authorizations (WAs), Change Orders Requests(CORs), and Change Orders (COs). All change documents will be monitored and managed by the City utilizing the DTCS. The DTCS will track "Ball in Court" status of all change documents.

1-9. DAILY REPORTS.

1-9.01. The Contractor is responsible for creating daily reports (daily diaries) utilizing the DTCS. The Contractor is required to enter the Daily Reports into the DTCS by 10:00 a.m. of the subsequent day that the Contractor or any subcontractor performs work. All daily reports shall be logged into the DTCS by the Contractor. The Contractor shall also provide one signed hard copy of all daily reports on a weekly basis. Required information shall include Contractor, Date, Day, Temperature, Precipitation, Sky, Wind, Work Activity, Equipment, Field Force, Visitors, Materials, and Scheduled Activities utilizing the Primavera schedule activity codes. Daily reports which fail to link work activities to the active Primaveraschedule will not be acceptable.

1-10. PUNCHLISTS.

1-10.01. The City will monitor and manage punch lists, and will create Punchlists to be forwarded to the Contractor. The Contractor shall address the Punchlist items that have been assigned to the Contractor and forward updates to the City. Once accepted as complete, the City will access the punchlist in the DTCS and close it out.

1-11. MEETING MINUTES AND AGENDA.

1-11.01. The City shall monitor and manage the meeting minute process. The City will forward meeting minutes to the Contractor electronically. The City will log the meeting

minute items into the DTCS within 3 days of the meeting date.

1-12. PROGRESS PAYMENTS /REQUISITIONS FOR PAYMENT.

1-12.01. The Contractor is responsible for creating progress payment applications directly from the Primavera scheduling software and then forwarding them to the City electronically along with hard copies by 4:00 p.m. at the end of each update/billing period. The Contractor shall also simultaneously provide a separate submittal of the updated Primavera progress schedule (P6 or latest version at the time of purchase), as specified in SC-16. All Progress Payments and schedule of values shall be developed as defined in the Special Conditions Required information within the Pay Application shall be coordinated with the City's Project Manager. Maintenance of the "As Built" record documents by the Contractor shall be verified before processing will be approved. Failure of a Contractor to maintain project record documents, maintain current and properly prepared daily reports or to submit the project schedule update per SC-16 will be just cause for withholding of the monthly or final payment.

1.13. LYNX PHOTO MANAGEMENT SOFTWARE.

1.13.01. The Lynx PM software shall be utilized by the City and the Contractor for the duration of the project. The daily construction photographs will be the permanent visual record of the pre-construction conditions, daily construction site activities, and the completion of construction work. The Contractor must submit to the City no less than four record photos for each activity ID listed in the project schedule per the last schedule update. Applicable photos must accompany each Pay Application.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

End of Section

SECTION 01400

QUALITY ASSURANCE/QUALITY CONTROL

PART 1 – GENERAL

1-1. SCOPE.

This section includes requirements for the implementation of the Contractor's quality assurance and quality control program.

Related sections:

1. Section 01410 Testing Laboratory Services.
2. General Conditions.
3. Section 01600, General Equipment and Material Requirements.
4. Section 01664, Training.

1-2. REFERENCES.

1-2.01. International Building Code 2012 (IBC) including 2014 Georgia State Amendments. Chapter 17 – Structural Tests and Special Instructions.

1-3. SITE INVESTIGATION AND CONTROL.

1-3.01. The Contractor shall check and verify all dimensions and conditions in the field continuously during construction. The Contractor shall be solely responsible for any inaccuracies built into the Work due to the Contractor's failure to comply with this requirement.

1-3.02. The Contractor shall inspect related and appurtenant Work and report in writing to the Engineer any conditions that will prevent proper completion of the Work. Failure to report such conditions shall constitute acceptance of all Site conditions, and any required removal, repair, or replacement caused by unsuitable conditions shall be performed by the Contractor solely and entirely at the Contractor's expense.

1-4. INSPECTION OF THE WORK.

1-4.01. All Work performed by the Contractor shall be inspected by the Contractor and non-conforming Work and any safety hazards in the work area shall be noted and corrective action shall be taken immediately. The Contractor is responsible for performing the Work safely and in conformance with the Agreement Documents.

1-4.02. The Work shall be conducted under the general observation of the Engineer and is subject to inspection by representatives of the Owner acting on behalf of the Owner to ensure strict compliance with the requirements of the Agreement Documents.

Such inspection may include mill, plant, shop, or field inspection, as required. The Engineer shall be permitted access to all parts of the Work, including plants where materials or equipment are manufactured or fabricated.

1-4.03. The presence of the Engineer, however, shall not relieve the Contractor of the responsibility for the proper execution of the Work in accordance with all requirements of the Agreement Documents. Compliance is the responsibility of the Contractor. No act or omission on the part of the Engineer, shall be construed as relieving the Contractor of this responsibility. Inspection of Work later determined to be non-conforming shall not be cause or excuse for acceptance of the non-conforming Work.

1-4.04. All materials and articles furnished by the Contractor shall be subject to rigid documented inspection, by qualified personnel, and no materials or articles shall be used in the Work until they have been inspected and accepted by the Contractor's Quality Control representative and the Engineer or other designated representative. No Work shall be backfilled, buried, cast in concrete, covered, or otherwise hidden until it has been inspected and approved by the Engineer. Any Work covered in the absence of inspection shall be subject to uncovering. Where uninspected Work cannot be easily uncovered, such as in concrete cast over reinforcing steel, all such Work shall be subject to demolition, removal, and reconstruction under proper inspection at the Contractor's expense.

1-4.05. All materials, equipment, and/or articles furnished to the Contractor by the Owner shall be subject to thorough inspection by the Contractor's Quality Control representative before being used or placed by the Contractor. The Contractor shall inform the Engineer, in writing, of the results of said inspections within one working day after completion of inspection. In the event the Contractor believes that any material or articles provided by the Owner to be of insufficient quality for use in the Work, Contractor shall immediately notify the Engineer.

1-5. TIME OF INSPECTION AND TESTS.

1-5.01. Samples required under these Specifications shall be furnished and prepared for testing in ample time for the completion of the necessary tests and analyses before said articles or materials are to be used. The Contractor shall furnish and prepare all required test specimens at the Contractor's own expense.

1-5.02. When the Contractor is ready to backfill, bury, cast in concrete, or otherwise cover any Work under this Contract, the Engineer shall be notified not less than three (3) Work Days in advance to request inspection before beginning any such Work of covering. Failure of the Contractor to notify the Engineer at least three (3) Work Days in advance of any such inspections shall be reasonable cause for the Engineer to order a sufficient delay in the Contractor's schedule to allow time for such inspection. The costs of any remedial or corrective work required, and all costs of such delays, including its

impact on other portions of the Work, shall be borne by the Contractor.

1-6. SAMPLING AND TESTING.

1-6.01. The Contractor shall retain and pay for an independent materials testing agency approved by the Engineer and the Owner per Article 1-8. The independent testing agency will develop and submit a testing plan for quality assurance on each type of work activity. The testing agency will document the processes and procedures utilized to verify and maintain quality work. When not otherwise specified, all sampling and testing shall be in accordance with the methods prescribed in the most current standards, as applicable to the class and nature of the article or materials considered. However, the Engineer reserves the right to use any generally accepted system of inspection which, in the opinion of the Engineer, will assure the Engineer that the quality of the workmanship is in full accord with the Agreement Documents. Copies of all test results are to be submitted to the Owner in a timely manner.

1-6.02. The Owner reserves the right to abbreviate, modify the frequency of, or waive tests or quality assurance measures. Waiver of any specific testing or other quality assurance measure shall not be construed as a waiver of any technical or qualitative requirements of the Agreement Documents. Whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the specified testing or other quality assurance requirements as originally specified, the waiver shall not be construed as a waiver of any technical or qualitative requirements of the Agreement Documents. Whether or not such guarantee is accompanied by a performance bond to ensure execution of any necessary corrective or remedial work, the waiver shall not be construed as a waiver of any technical or qualitative requirements of the Agreement Documents.

1-6.03. Notwithstanding the existence of such waiver, the Owner shall reserve the right to make independent investigations and tests as specified in the following paragraph. Failure of any portion of the Work to meet any of the qualitative requirements of the Agreement Documents shall be reasonable cause for the Owner to require the removal or correction and reconstruction of any such Work.

1-6.04. In addition to any other inspection or quality assurance provisions that may be specified, the Owner shall have the right to independently select, or request a second test, and analyze, at the expense of the Owner, additional test specimens of any or all of the materials to be used. Results of such tests and analyses shall be considered, along with the tests or analyses made by the Contractor, to determine compliance with the applicable specifications for the materials so tested or analyzed. Wherever any portion of the Work is discovered, as a result of such independent testing or investigation by the Engineer, which fails to meet the requirements of the Agreement Documents, all costs of such independent inspection and investigation and all costs of removal, correction, reconstruction, or repair of any such Work shall be borne by the

Contractor.

1-7. CONTRACTOR'S QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS.

1-7.01. The Contractor shall establish and execute a Quality Assurance/Quality Control (QA/QC) program for the services that are being procured from the Contractor. The program shall provide the Contractor with adequate measures for verification and conformance to defined requirements by his personnel and lower-tier subcontractors (including fabricators, suppliers, and sub-subcontractors). This program shall be described in a QA/QC Plan responsive to this Section. It shall utilize the services of an independent testing agency/company that is industry certified to provide QA/QC and compliance with the standards specified.

1-7.02. The Contractor shall furnish the Engineer a project specific QA/QC Plan. The Plan shall contain a comprehensive account of the Contractor's QA/QC procedures as applicable to this job. The Contractor shall furnish for review by the Engineer, no later than fourteen (14) days after receipt of the Notice to Proceed, the QA/QC Plan proposed to be implemented. The QA/QC Plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. Construction will be permitted to begin only after acceptance of the QA/QC Plan. The detailed requirements for this QA/QC Plan are delineated in the following paragraphs. No payments will be made to the Contractor until the QA/QC Plan is approved by the Engineer.

1-7.03. The QA/QC Plan shall describe and define the personnel requirements described herein. The Contractor shall employ a full time on-site Field QA/QC Manager to manage, address, and resolve all QA/QC issues.

The QA/QC Manager shall be as identified by the Contractor and agreed to by the Owner. A resume for the potential QA/QC Manager shall be submitted to the Owner for review and approval. The QA/QC Manager shall have a minimum of ten (10) years of experience in the construction of water/wastewater treatment plant and/or conveyance system. The QA/QC Manager shall be onsite at all times while work is being performed by the contractor, to ensure that work is being performed properly and to routinely observe all Work in progress. This individual shall be responsible only for QA/QC activities and shall have no supervisor managerial responsibility other than the QA/QC. No change in the QA/QC Manager may occur without written consent of the Owner, and the prior approval of a replacement.

The Contractor shall provide additional personnel who are assigned to assist the QA/QC Manager fulfill the requirements of the QA/QC Plan. The Contractor shall provide a letter (to the QA/QC Manager) signed by an authorized official of the firm empowering the QA/QC Manager to address quality issues, and if necessary, to stop work which is not in compliance with the contract. The QA/QC Manager shall issue

letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Owner.

1-7.04. The Contractor's QA/QC program shall ensure and substantiate quality throughout all areas of the contract. A customized QA/QC Plan shall be developed that discusses each type of work for which the Contractor is responsible within the Project. The QA/QC Plan shall describe the program, include procedures, work instructions, records, and a description of the quality control organization.

The description of the quality control organization shall include a chart showing lines of authority, staffing plan, and acknowledgment that the QA/QC staff shall implement the system for all aspects of the work specified. The staffing plan shall identify the name, qualifications (in résumé format), duties, responsibilities, and authorities of each person assigned a QA/QC function including the QA/QC Manager. In addition, the Plan shall describe methods relating to areas that require special testing and procedures as noted in the specifications.

This plan shall require a preparatory installation training, follow-up monitoring and ongoing observation of the work.

The preparatory installation training class attendance will be required by the Contractor's and/or sub-contractor's crews before the start of each new construction activity. The Owner will attend and monitor the training. This training will consist of a hands-on demonstration of the work activities by the crews. The contractor crews shall demonstrate proper construction techniques in the performance of the work. No crews may begin work prior to successfully completing the preparatory installation training. This training will be monitored by the contractor's QA/QC Manager, Safety Manager and supervisory personnel. The QA/QC Manager shall submit a certification to the Engineer after each training session that the work crew have attended and successfully completed the training.

The follow-up monitoring will take place no later than 10 days after the preparatory installation training. The follow-up monitoring will require the work crews to continue to demonstrate the proper means and methods of construction as performed in the preparatory installation training class. If in the sole judgment of the Engineer that the Work is not being performed as per the QA/QC Plan and/or the Agreement Documents, the crews shall discontinue the Work and will be required to attend the preparatory training class, again. The QA/QC Manager shall submit a certification to the Engineer after each follow-up training session that the work crews have continued to perform the Work per the QA/QC Plan and/or Agreement Documents. Any retraining will be at no cost to the Owner.

Ongoing inspections will take place throughout the duration of the Project. The on-

going monitoring will require the work crews to demonstrate the proper means and methods of construction as performed in the preparatory class. If in the judgment of the Engineer that the Work is not being performed as per the QA/QC Plan and/or the Agreement Documents the crews shall be required to attend the preparatory training class, again. Any retraining will be at no cost to the Owner.

1-7.05. Identification and Control of Items and Materials: Procedures to ensure that items or materials that have been accepted at the site are properly used and installed shall be described in the QA/QC Plan. The procedures shall provide for proper identification and storage, and prevent the use of incorrect or defective materials.

1-7.06. Inspection and Tests: The Contractor shall have written procedures defining a program for control of inspections performed and these procedures shall be described in the QA/QC Plan.

Inspections and tests shall be performed and documented by qualified individuals. At a minimum, "qualified" shall mean having performed similar QA/QC functions on similar type projects for a minimum of five (5) years and possession of industry standards certification and license. Records of personnel experience, training, and qualifications shall be submitted to the Engineer for review and approval.

The Contractor shall maintain and provide to the Engineer, within two working days of completion of each inspection and test, adequate records of all such inspections and tests. Inspection and test results shall be documented and evaluated to ensure that requirements have been satisfied.

Procedures shall include:

Specific instructions defining procedures for observing all Work and comparing the Work with the Contract requirements (organized by specification section).

Maintaining and providing Daily QA/QC Inspection Reports. Such reports shall, at a minimum, include the following:

a. Dated list of Item(s) inspected.
b. Location of the test sample(s).
c. Logs, detailed location drawings and confirmation reports.
d. Quality characteristics in compliance.
e. Quality characteristics not in compliance.
f. Corrective/remedial actions taken.
g. Statement of certification.
h. QC Manager’s signature.

Specific instructions for recording all observations and requirements for demonstrating through the reports that the Work observed was in compliance or a deficiency was

noted and action to be taken.

Procedures to preclude the covering of deficient or rejected Work.

Procedures for halting or rejecting Work.

Procedures for resolution of differences between the QA/QC representative(s) and the production representative(s).

Method of documenting QA/QC process and results including:

a. Automatic exception reporting.
b. Resolution tracking.
c. Quality Confirmation Test reports.
d. Sample retention index and storage.

The QA/QC Plan shall identify all contractual hold/inspection points as well as any Contractor imposed hold/inspections points.

The QA/QC Plan shall include procedures to provide verification and control of all testing provided by Contractor including:

1. Individual test records will contain the following information:
   a. Item tested – item number and description.
   b. Test results.
   c. Test designation.
   d. Test work sheet including location sample was obtained.
   e. Acceptance or rejection.
   f. Date sample was obtained.
   g. Retest information, if applicable.
   h. Control requirements.
   i. Tester signature.
   j. Testing QC staff initials.
2. Maintaining and providing to the Engineer Daily Testing Records. Such records shall, at a minimum, contain the following:
   a. Dated list of Item(s) inspected.
   b. Location of the test sample(s) Logs, detailed location drawings and confirmation reports.
   c. Quality characteristics in compliance.
   d. Quality characteristics not in compliance.
   e. Corrective/remedial actions taken.
   f. Statement of certification.

QA/QC Manager's signature providing for location maps/drawings (i.e. lift drawings, instrument loop sheets, laying schedules, etc.) for all tests performed or location of

Work covered by the tests.

Maintaining copies of all test results.

Ensuring Engineer receives a copy of all tests directly from lab(s).

Ensuring testing lab(s) are functioning independently of Contractor in accordance with the specifications.

Ensuring re-tests are properly taken and documented.

Special Inspection and Documentation: In addition to the above inspection requirements, certain Special Inspection and Documentation requirements may be contained in the specification Sections. Perform Special Inspection and Documentation and submit a record showing results on an "as occurred" basis unless otherwise indicated.

The Contractor will employ separate qualified persons to provide Special Inspections required by reference 1.02 A., above, and as detailed in the Statement Special Inspections. The Contractor may employ an Independent Testing Laboratory (ITL), other inspection entities, or combinations of the above to perform Special Inspections.

1-7.07. Control of Measuring and Test Equipment: Measuring and/or testing instruments shall be adequately maintained, calibrated, certified and adjusted to maintain accuracy within prescribed limits. Calibration shall be performed at specified periods against valid standards traceable to nationally recognized standards and documented. Copies of measuring and / or testing instrument certifications shall be on file with the QA/QC Manager.

1-7.08. Supplier Quality Assurance: The QA/QC Plan shall include procedures to ensure that procured products and services conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to lower-tier suppliers and/or subcontractors. QA/QC inspections and certifications may not be deferred to the Contractor’s subs or suppliers.

1-7.09. Deficient, Defective, and Non-conforming Work; Corrective Action: The QA/QC Plan shall include procedures for handling deficiencies and non-conformances. Deficiencies and non-conformances are defined as documentation, drawings, material, and equipment or Work not conforming to the specified requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent recurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documented and measures implemented to prevent recurrence. In

addition, at a minimum, this procedure shall address:

1. Personnel responsible for identifying deficient and non-complying items within the work.
2. How and by whom deficient and non-compliant items are documented “in the field”.
3. The personnel and process utilized for logging deficient and non-compliant work at the end of each day onto a Deficiency Log.
4. Tracking processes and tracking documentation for Deficient and Non-Compliant items.
5. Personnel responsible for achieving resolution of outstanding deficiencies.
6. Once resolved, how are the resolutions documented and by whom.

1-7.10. Special Processes and Personnel Qualifications: The QA/QC Plan shall include detailed procedures for the performance and control of special process (e.g. welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).

Personnel performing special process tasks shall have the experience, training and certifications commensurate with the scope, complexity, or nature of the activity. They shall be approved by the Engineer before the start of Work on the Project.

1-7.11. Audits: The Contractor’s QA/QC program shall provide for documented audits to verify that QA/QC procedures are being fully implemented by the Contractor as well as its subcontractors and suppliers. Audit records shall be made available to the Engineer upon request. Quarterly reports will be provided to the Owner indicating any outstanding and unresolved exceptions to the QA/QC program or Agreement Documents. This will include documentation on any standards modifications, corrections, failed tests, and a review of field procedures and checks and balances effectiveness.

1-7.12. Documented Control/Quality Records. The Contractor shall establish methods for control of Agreement Documents that describe how Drawings and Specifications are received and distributed to assure the correct issue of the document being used. The methods shall also describe how as-built data are documented and furnished to the Engineer.

The Contractor shall maintain evidence of activities affecting quality, including operating logs, records of inspections and tests, audit reports, material analyses, personnel qualification and certification records, procedures, and document review records.

Quality records shall be maintained in a manner that provides for timely retrieval, and traceability. Quality records shall be protected from deterioration, damage, and destruction. The Contractor shall maintain an automated exceptions list of any non-conforming or defective or substandard work.

The Contractor shall provide a list with specific records as specified in the Agreement Documents to the Engineer at the completion of activities and in conjunction with logs and locational drawings.

1-7.13. Acceptance of QA/QC Plan: Engineer's review and acceptance of the Contractor's QA/QC Plan shall not relieve the Contractor from any of its obligations for the performance of the Work. The Contractor's QA/QC staffing is subject to the Engineer's review and continued acceptance. The Owner, at its sole option, without cause, may direct the Contractor to remove and replace the QA/QC representative. No Work covered by the QA/QC Plan shall start until Engineer's acceptance of Contractor's QA/QC plan has been obtained.

1-7.14. Engineer may perform independent quality assurance audits to verify that actions specified in Contractor's QA/QC Plan have been implemented. No Engineer audit finding or report shall in any way relieve Contractor from any requirements of this Contract.

1-8. TESTING SERVICES.

1-8.01. All tests which require the services of a laboratory to determine compliance with the Agreement Documents shall be performed by an independent commercial testing firm approved by the Engineer as specified in Section 01410-Testing Laboratory Services. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified standards. All standard quality assurance testing and installation verification testing will be at the expense of the Contractor.

1-8.02. Testing, when required, will be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

1-8.03. The Engineer shall have the right to inspect work performed by the independent testing laboratory both at the project and at the laboratory. This shall include inspection of the independent testing laboratory's internal quality assurance records (quality assurance manual, equipment calibrations, proficiency sample performance, etc.).

1-8.04. The Contractor shall obtain the Engineer's approval of the testing firm before having services performed, and shall pay all costs for these testing services.

1-8.05. Testing services provided by the Owner, if any, are for the sole benefit of the Owner, however, test results shall be made available to Contractor. Testing necessary to satisfy the Contractor's internal quality control procedures shall be the sole responsibility of the Contractor.

1-8.06. Testing Services Furnished By The Contractor: Unless otherwise specified, and in conjunction with, all other specified testing requirements, the Contractor shall provide the following testing services, and write up a detailed testing plan for each along with proposed forms for the Engineer's review:

1. Continuity and insulation megger testing.
   a. All Circuits.
   b. All Motors 25hp and greater.
2. Individual component calibration and testing.
   a. Instrument loop testing.
3. Calibration of fixed instruments.
4. Process / Mechanical/ Drainage pipe testing.
   a. Cleaning and flushing of all process / mechanical piping.
5. Equipment tests.
   a. Factory tests.
   b. Field functional, operational, and performance tests.
6. Tanks.
   a. All water-retaining concrete structures shall be tested for water tightness in accordance with ACI 350.1R.
7. Flow meter (installed) calibration / testing.
8. System acceptance testing.
9. Concrete tests.
10. Moisture-density and relative density tests on embankment, fill, and backfill materials.
11. In-place field density test on embankments, fills, and backfill.
12. Other materials and equipment as specified herein.
13. Concrete materials and mix designs.
14. Embankment, fill, and backfill materials, density, optimum moistures and compaction.
15. QC testing of all precast and/or pre-stressed concrete.
16. All other tests and engineering data required for Engineer's review of materials and equipment proposed to be used in the Work.
17. In addition, the following QC tests shall be performed by Contractor:
    a. Holiday testing of pipeline and all other coatings systems applied to surfaces as required by the Engineer.
    b. Slumps, air bucket tests, compression tests and other confirmation tests.
    c. Air testing of field-welded joints for steel pipe or pipe cylinders and fabricated specials.
    d. All testing and inspection of welding work including, but not limited to, welding procedure qualifications, welder operator qualifications, all work performed by the certified welding inspector, all appropriate nondestructive testing of welds and all repair and retest of weld defects.
18. Testing, including sampling, shall be performed by the Contractor's testing firm's laboratory personnel, in general manner and frequency indicated in the Specifications. The Engineer and/or the Owner's representative shall have the

right to stipulate the location of the confirmation tests. The Contractor shall provide preliminary representative samples of materials to be tested to laboratory, in required quantities.

19. The testing firm's laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and will furnish a written report of each test.
20. The Contractor shall furnish all sample materials and cooperate in the testing activities, including sampling. The Contractor shall interrupt the Work when necessary to allow testing, including sampling to be performed. The Contractor shall have no claim for an increase in Contract Price or Contract Times due to such interruption. The Contractor shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.
21. When testing activities, including sampling are performed in the field by the testing firm's laboratory personnel, the Contractor shall furnish required labor and facilities.
    a. To provide access to Work to be tested.
    b. To obtain and handle samples at the site of the Work.
    c. To facilitate inspections and tests.
    d. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.
22. Where such inspection and testing are to be conducted by an independent laboratory agency, the sample or samples shall be selected by such laboratory or agency or the Engineer and shipped to the laboratory by the Contractor at Contractor's expense.
23. The Contractor shall notify the testing laboratory sufficiently in advance of operation to allow for the assignment of personnel and schedules of tests.
24. The Contractor shall be responsible for furnishing all materials necessary for testing.

1-8.07. Transmittal of Test Reports: Written reports of tests and engineering data furnished by the Contractor for the Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings. Final transmittal of all Project testing records shall be required as a final close-out submittal for the release of retainage.

The Contractor shall promptly process and distribute all required copies of test reports and related instructions to ensure all necessary retesting or replacement of materials with the least possible delay in progress of the Work.

1-8.08. The Contractor shall provide copies of all correspondence between the Contractor and testing agencies to the Engineer.

1-8.09. Inspections and tests required by codes or ordinances or by a plan approval

authority, and made by a legally constituted authority, shall be the responsibility of and shall be paid for by the Contractor, unless otherwise provided in the Agreement Documents.

1-8.10. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

1-8.11. Schedules for Testing

Establishing Schedule:

1. The Contractor shall, by advance discussion with the testing laboratory determine the time required for the laboratory to perform its tests and to issue each of its findings, and make all arrangements for the testing laboratory to be on site to provide the required testing.
2. The Contractor shall provide for all required time within the construction schedule.
3. When changes of construction schedule are necessary during construction, the Contractor shall coordinate all such changes of schedule with the testing laboratory as required.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

End of Section

SECTION 01410

TESTING LABORATORY SERVICES

PART 1 - GENERAL

1-1. SCOPE.

From time to time during progress of the Work, the Engineer may require that testing be performed to determine that materials provided for the Work meet the specified requirements, in accordance with the requirements of the Specifications. Such testing includes, but is not necessarily limited to:

1. Cement
2. Aggregate
3. Concrete
4. Concrete block
5. Pipe
6. Steel and metals
7. Welding
8. Soil compaction
9. Bituminous pavement

1-1.01. Requirements for testing may be described in various sections of these Specifications; where no testing requirements are described but the Engineer decides that testing is required to demonstrate compliance with specified material or performance standards, the Engineer may require testing to be performed under current pertinent standards for testing.

1-1.02. Employment of a testing laboratory shall in no way relieve the Contractor of Contractor's obligation to perform work meeting the requirements of the Contract.

1-1.03. The independent testing laboratory shall be selected and paid by the Contractor and approved in writing by the Engineer before any testing services are performed.

1-1.04. The Contractor shall pay directly for the services of the independent testing laboratory, approved by the Engineer, for all testing required under this Contract.

1-2. LABORATORY DUTIES.

Cooperate with Engineer and Contractor.

1-2.02. Provide qualified personnel promptly on notice.

1-2.03. Perform specified inspections, sampling and testing of materials and methods of

construction.

1. Comply with specified standards, ASTM, other recognized authorities and as specified.
2. Ascertain compliance with requirements of Contract Documents.

1-2.04. Promptly notify Engineer and Contractor of irregularity or deficiency of work which are observed during performance of services.

1-2.05. Promptly submit three (3) copies to Engineer and one (1) copy to Contractor of report of inspections and tests in addition to those additional copies required by the Contractor including:

1. Date issued
2. Project title and number
3. Testing laboratory name and address
4. Name and signature of inspector
5. Date of inspection or sampling
6. Record of temperature and weather
7. Date of test
8. Identification of product and Specification section
9. Location of Project
10. Type of inspection or test
11. Results of test
12. Observations regarding compliance with Contract Documents

1-2.06. Perform additional services as required.

1-2.07. Laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of Contract Documents.
2. Approve or accept any portion of Work.

1-3. CONTRACTOR RESPONSIBILITIES.
Cooperate with laboratory personnel, provide access to Work and/or manufacturer's requirements.

Provide to laboratory, preliminary representative samples, in required quantities, of materials to be tested.

Furnish copies of mill test reports.

Furnish required labor and facilities.

1. To provide access to Work to be tested
2. To obtain and handle samples at the site
3. To facilitate inspections and tests
4. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.

Notify laboratory sufficiently in advance of operation to allow for the assignment of personnel and schedules of tests.

1-3.01. Laboratory Tests. Where such inspection and testing are to be conducted by an independent laboratory agency, the sample or samples shall be selected by such laboratory or agency or the Engineer and shipped to the laboratory by the Contractor at Contractor's expense.

1-3.02. Copies of all correspondence between the Contractor and testing agencies shall be provided to the Engineer.

1-4. QUALITY ASSURANCE.
Testing, when required, will be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

1-5. PRODUCT HANDLING.
Promptly process and distribute all required copies of test reports and related instructions to insure all necessary retesting or replacement of materials with the least possible delay in progress of the Work.

1-6. FURNISHING MATERIALS.
The Contractor shall be responsible for furnishing all materials necessary for testing.

1-7. CODE COMPLIANCE TESTING.
Inspections and tests required by codes or ordinances or by a plan approval authority, and made by a legally constituted authority, shall be the responsibility of and shall be paid for by the Contractor, unless otherwise provided in the Contract Documents.

1-8. CONTRACTOR'S CONVENIENCE TESTING.
Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

1-9. SCHEDULES FOR TESTING.
Establishing Schedule:

The Contractor shall, by advance discussion with the testing laboratory determine the time required for the laboratory to perform its tests and to issue each of its findings, and

make all arrangements for the testing laboratory to be on site to provide the required testing.

Provide all required time within the construction schedule.

When changes of construction schedule are necessary during construction, coordinate all such changes of schedule with the testing laboratory as required.

1-10. TEST AND CERTIFICATIONS.

1-10.01. General. As a minimum, the following tests shall be performed and the following certifications provided:

Cement: Certified test results by cement manufacturer or by independent laboratory shall be furnished as required by the Engineer.

Aggregate and Mortar Sand: Certified test results by aggregate producer or by independent laboratory shall be furnished as required by the Engineer.

Concrete

a. At least five (5) standard 6-inch cylinders shall be taken each day for each 100 cubic yard or fraction thereof for each class of concrete used.
b. The number of cylinders, the point of sampling, and the method of securing the samples shall be determined by the Engineer.
c. The five (5) samples shall be taken to the testing laboratory for laboratory curing.
d. Two (2) of the laboratory cured samples shall be tested at 7 days, two (2) samples tested at 28 days; one (1) sample in reserve.
e. Test all concrete in accordance with ASTM C31-69, C39-71 and C-172.
f. Slump Tests
    (1) Perform slump tests on the job in accordance with ASTM standards.
    (2) One (1) slump test shall be performed for each 25 cubic yards of concrete.
    (3) More slump tests shall be performed if deemed necessary by the Engineer.
g. Perform air entrainment tests in accordance with the following standards:
    (1) Field tests - ASTM C 173
    (2) Laboratory tests - ASTM C 231

1-10.02. Precast and Concrete Block for Buildings. Block and precast may be visually inspected on the site by the Engineer. The Engineer reserves the right to have the concrete block tested by an independent laboratory.

1-10.03. Steel and Miscellaneous Metal. Reinforcing steel, structural steel and

miscellaneous metal may be inspected visually on the site by the Engineer.

1-10.04. Welding. 1 percent of all structural welds during construction shall be inspected either visually or by an independent laboratory as required by the Engineer.

1-10.05. Compaction of Earthwork. The compaction shall be tested by the Engineer or by an independent laboratory. The testing shall be performed in a manner in accordance with these Specifications.

1-10.06. Bituminous Concrete. The material testing for the bituminous concrete shall be performed by an independent laboratory as deemed necessary by the Engineer.

1-11. TAKING SPECIMENS. Unless otherwise provided in the Contract Documents, all specimens and samples for tests will be taken by the testing laboratory or the Engineer.

1-12. TRANSPORTING SAMPLES. The Contractor shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

End of Section

Section 01450

CODE REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 - GENERAL

1-1. SCOPE. Owner, or Registered Design Professional in Responsible Charge of construction acting as Owner's Agent, will engage one or more Approved Agencies to conduct tests and special inspections specified in this section and related sections, and as may be specified in other sections of these specifications. The Approved Agency shall not be employed by Contractor or a supplier materially participating in the project.

1-2. GENERAL. This Section includes administrative and procedural requirements indicated in the governing building code.

Structural testing and special inspection services are required to verify compliance with the construction documents and standards referenced herein. These services do not relieve Contractor of responsibility for compliance with the construction documents.

Specific quality-assurance and quality-control requirements for individual construction activities are also referenced in other Sections. Requirements in those Sections may also cover production of standard products.

Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the construction documents.

Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or Authority Having Jurisdiction (AHJ) are not limited by provisions of this Section.

1-3. DEFINITIONS.

Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the Authority Having Jurisdiction.

Approved Fabricator: An established and qualified person, firm or corporation registered and approved by the Authority Having Jurisdiction to perform work without Special Inspection.

Authority Having Jurisdiction (AHJ): The officer or other designated authority charged with the administration and enforcement of the building code, or a duly authorized representative. Also commonly known as the Building Official.

Construction Documents: Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit. Construction documents include all supplemental instructions, sketches, addenda, and revisions to the drawings and specifications issued by the Registered Design Professional beyond those issued for a building permit.

Pre-Engineered Structural Elements: Structural elements specified by the Registered Design Professional but which may be designed by another Registered Design Professional. (Examples are items such as open web steel joists and joist girders, metal joists, pre-cast concrete elements, pre-fabricated metal buildings, pre-stressed wire wrapped tanks, tilt-up concrete panel reinforcement and lifting hardware.)

Registered Design Professional (RDP): An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

Registered Design Professional in Responsible Charge (RDPRC): A Registered Design Professional engaged by Owner to review and coordinate certain aspects of the project, as determined by the AHJ and Construction Documents, for compatibility with the design of the buildings or structure, including submittal documents prepared by others, deferred submittal documents and phased submittal documents.

Shop Drawings / Submittal Data: Written, graphic and pictorial documents prepared and / or assembled by Contractor or Supplier based on the Construction Documents.

Special Inspection: Inspection and/or testing required by the governing building code, as amended by the AHJ, of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved Construction Documents and referenced standards.

Special Inspection, Continuous: The full-time observation or testing of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed.

Special Inspection, Periodic: The part-time or intermittent observation or testing of work requiring Special Inspection by an approved Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.

Special Inspector: A qualified person demonstrating competence, to the satisfaction of the AHJ and RDPRC, for inspection of the particular type of construction or operation requiring special inspection. The Special Inspector will be qualified as specified herein.

Structural Observations: Visual observation of the structural system by a Registered Design Professional for general conformance to the approved Construction Documents. Structural observations are not considered part of the tests and special inspections and do not replace inspections and testing by the Approved Agency. Owner will employ a RDP to perform Structural Observations.

Testing Agency: A qualified materials testing laboratory under the responsible charge of a Registered Design Professional, approved by the AHJ and the RDPRC, to measure, examine, test, calibrate, or otherwise determine the characteristics or performance of construction materials and verify confirmation with construction documents.

1-4. INSPECTION AND TESTING AGENCY QUALIFICATIONS. Special Inspectors and testing agencies will be employed or retained by Owner, and will have the minimum qualifications as described in this section. The qualifications of all personnel performing special inspection and testing activities are subject to the approval of the AHJ.

Minimum qualifications of inspection and testing agencies and their personnel will comply with ASTM E329 “Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection,” or IAS AC 291 “Accreditation Criteria for Special Inspection Agencies.”

Inspectors and individuals performing tests will be certified for the work being performed as listed below and in Table 1 of IAS AC291, or by alternate certifications when acceptable to the AHJ. The AHJ may have additional requirements.

Abbreviation used in this Section	**Description**
AIA	Architect licensed in the state of the project, specializing in the design of building structures
Licensed Engineers	
PE/SE	Structural Engineer (SE) or Professional Engineer (PE) licensed in the state of the project, specializing in the design of building structures
PE/GE	Geotechnical Engineer (GE) or Professional Engineer (PE) licensed in the state of the project, specializing in soil mechanics and foundations
PE/EE	Electrical Engineer (EE) or Professional Engineer (PE) licensed in the state of the project, specializing in electrical systems
PE/ME	Mechanical Engineer (ME) or Professional Engineer (PE) licensed in the state of the project, specializing in mechanical systems

Abbreviation used in this Section	Description
EI/EIT	Engineering Intern or Engineer-in-Training: a graduate engineer who has passed the Fundamentals of Engineering examination working under the direct supervision of a Professional Engineer licensed in the state of the project and with a minimum of one year of experience performing inspections.
American Concrete Institute (ACI) Certification	
ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1 or 2
ACI-STT	Strength Testing Technician
American Welding Society (AWS) Certification	
AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector
American Society of Non-Destructive Testing (ASNT) Certification	
ASNT	Non-Destructive Testing Technician For Ultrasonic Testing (UT) and Radiographic Testing (RT) Certified as Level III through examination by ASNT or certified as Level II by their employer for flaw detection. For Magnetic Particle Testing (MT) and Liquid Penetrant Testing (PT) certified as Level II by their employer or certified as Level III through examination by ASNT and certified by their employer
International Code Council (ICC) Certification	
ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fire-proofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector
ICC-SBSI	Structural Steel and Bolting Special Inspector
ICC-WSI	Structural Welding Special Inspector
National Concrete Masonry Association	
NCMA	Concrete Masonry Testing Technician
National Institute for Certification in Engineering Technologies (NICET)	

Abbreviation used in this Section	Description
NICET-CT	Concrete Technician – Levels II, III & IV
NICET-ST	Soils Technician - Levels II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels II, III & IV
Exterior Design Institute (EDI) Certification	
EDI-EIFS	EIFS Third Party Inspector

Inspection or Testing Item	Qualification Standards
Fabricators	Varies by product as listed below
Steel Construction – Welding Inspection	ICC-SWSI, ICC-WSI, AWS-CWI or AWS/AISC-SSI
Steel Construction – Non-Destructive Weld Testing	ASNT
Steel Construction – Details	PE/SE, ICC-SWSI, ICC-SBSI or AWS/AISC-SSI
Steel Construction – High Strength Bolts	PE/SE or ICC-SBSI
Concrete Construction - Field Tests	ACI-CFTT or NICET-CT
Concrete Construction - Field Inspection	PE/SE, ICC-RCSI, ACI-CCI or NICET-CT
Concrete Construction - Laboratory Testing	ACI-LTT, ACI-STT or NICET-CT
Prestressed Concrete Construction	ICC-PCSI
Masonry Construction - Field Inspection	PE/SE or ICC-SMSI
Masonry Construction - Laboratory Testing	NCMA
Soils (special grading, excavation and filling)	PE/GE, NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Pile Foundations	PE/GE, Appropriate structural material inspection and NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Pier Foundations	PE/GE, Appropriate structural material inspection and NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Wall Panels and Veneers	ICC-SMSI
Sprayed Fire-Resistant Materials	ICC-SFSI
Exterior Insulation and Finish Systems (EIFS)	ICC Building Inspector or EDI-EIFS
Post Installed Anchors in Concrete	ICC Building Inspector, ICC-RCSI, or PE/SE
Post Installed Anchors in Masonry	ICC Building Inspector, ICC-SMSI, or PE/SE
Smoke Control Systems	IBC 1705.17.2

Inspection or Testing Item	Qualification Standards
Other Architectural Systems	ICC Building Inspector, AIA, or PE/SE
Mechanical Systems	ICC Building Inspector or PE/ME
Electrical Systems	See NFPA 70

1-4.01. Structural Steel Testing Agency Requirements. Submit the following to the RDPRC and the AHJ prior to beginning testing:

Written practices for monitoring and control of the inspection and testing agency operations including

Inspection and testing agency's procedures for the selection and administration of inspection personnel, describing the training, experience, and examination requirements for qualification and certification of inspection personnel.

Inspection and testing agency's inspection procedures, including general inspection, material controls, and visual welding inspection.

Qualifications of management and quality assurance personnel designated for the project.

Qualification records for inspectors and NDT technicians designated for the project.

NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.

1-5. CONFLICTING REQUIREMENTS, REPORTS AND TEST RESULTS.

1-5.01. General. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the RDPRC for a decision before proceeding.

1-5.02. Minimum Quantity or Quality Levels. The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the RDPRC for a decision before proceeding.

1-5.03. Precedence. The Approved Agency reports and testing results shall have precedence over reports and test results provided by Contractor.

1-5.04. Conflict. Where a conflict exists between the construction documents and approved shop drawings/submittal data, the construction documents shall govern unless the shop drawings/submittal data are more restrictive. All conflicts shall be brought to the attention of the RDPRC.

1-6. TECHNICAL ATTACHMENTS. The following forms are required as part of the comprehensive administrative, testing and inspection requirements. The forms are available from the AHJ, or are included herein, as indicated:

Form Title	AHJ Provided	Included Herein	Notes
Statement of Special Inspections (SSI)		x	To be completed jointly by the RDPRC and the Approved Agency, and sealed by the RDPRC after completion. Contractor or Owner shall submit the form to the AHJ as part of the building permit application process.
Request for Approval of Special Inspector		x	To be completed by Approved Agency. Approved Agency will submit the form to the AHJ and RDPRC for their approval of individual inspectors.
Request for Approval to Provide Special Inspection of Non-Local Fabrication		x	To be completed by Approved Agency and submitted to Owner, AHJ and RDPRC.
Contractor's Statement of Responsibility		x	To completed by Contractor and his relevant suppliers and submitted to Owner and AHJ.
Fabricator's Certificate of Compliance		x	To be completed by Contractor's fabricators, as applicable, and submitted to AHJ.
Final Report of Special Inspections		x	To be completed and sealed by Approved Agency. Approved

			Agency or Owner will submit to AHJ at the completion of construction.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3-1. CONTRACTOR AND FABRICATOR RESPONSIBILITIES. Each Fabricator or Contractor responsible for the construction of a seismic-force-resisting system, designated seismic system, seismic resisting component, main wind force-resisting system, or a wind-resisting component listed in the SSI shall submit a Contractor's Statement of Responsibility to the AHJ and to Owner prior to the commencement of work.

To be considered an Approved Fabricator that may perform work without Special Inspection, the Fabricator shall submit copies of certifications from the International Accreditation Service (IAS) or other recognized and acceptable accreditation organization a minimum of 30 days prior to the start of fabrication. Acceptance as an Approved Fabricator is subject to approval by the AHJ. If the project specifications required an Approved Fabricator, and the AHJ does not accept the Fabricator as an Approved Fabricator, special inspection may become necessary in the fabricator's shop. Such inspections will be performed by Approved Agency and Contractor shall reimburse Owner for the cost for the inspections.

Contractor shall assist in coordination of the inspection and testing services with the progress of the work. Contractor shall provide sufficient notice to allow proper scheduling of all inspection and testing personnel. Contractor shall provide safe access to inspection and testing personnel and shall ensure that all work requiring special inspection is inspected and/or tested prior to concealment.

Contractor shall submit schedules to Owner, RDPRC and testing and inspecting agencies. Schedules will note milestones and durations of time for materials requiring tests and special inspections.

Contractor shall provide the Special Inspector access to approved plans at the job site or fabrication shop as applicable.

Contractor shall retain at the job site or fabrication shop, as applicable, all special inspection records submitted by an Approved Agency or Special Inspector and shall provide these records for review by the AHJ's inspector upon request.

Contractor shall repair and/or replace work that does not meet the requirements of the construction documents.

Contractor shall engage an engineer to prepare repair and/or replacement procedures for any deficiencies identified. Contractor's engineer shall be registered in the state in which the project is located. Contractor's engineer shall be acceptable to the RDPRC, AHJ, and Owner. Procedures shall be submitted for review and acceptance by the RDPRC, AHJ, and Owner before proceeding with corrective action.

Contractor shall be responsible for costs of:

Re-testing and re-inspection of materials, work, and/or products that do not meet the requirements of the Contract Documents or shop drawing/submittal data.

Review of proposed repair and/or replacement procedures by the RDPRC and the inspectors and testing agencies.

Repair or replacement of work that does not meet the requirements of the Construction Documents.

3-2. APPROVED AGENCY AND SPECIAL INSPECTOR RESPONSIBILITIES.

3-2.01. Preliminary Approvals. The Approved Agency will submit a "Request for Approval of Special Inspector" form to the AHJ for each proposed Special Inspector or testing technician. The form will include the individual's credentials, which as a minimum will meet the requirements indicated in Paragraph 1-4 in this Section. Inspector certifications by organizations other than those listed herein will not be acceptable without approval of the AHJ. The AHJ may have additional requirements to those specified herein. It is the responsibility of the testing and inspection agencies to meet local requirements and comply with local procedures.

When fabrication will take place away from the local proximity of the project, Approved Agency will submit a "Request for Approval to Provide Special Inspection of Non-Local Fabrication" form for review and approval by Owner, the RDPRC, and the AHJ prior to subcontracting with an inspection/testing agency in the locale of the fabricating plant.

3-2.02. Perform Inspections and Tests. Be present for and perform continuous or periodic inspections and tests as listed in the SSI for conformance of the work to the AHJ approved Construction Documents. Notify Contractor personnel of their presence and responsibilities. Reference the applicable "Code or Standard Reference" column in the SSI for the minimum level of inspections and testing. When the SSI column titled "Code or Standard Reference" indicates "Manufacturer's research reports", inspector will obtain the most current ICBO-ES Report, ICC-ES Legacy Report, ICC-ES Report, or

IAPMO UES Evaluation Report (as applicable) prior to the applicable inspection, for the type and brand of products or materials being inspected.

Provide additional inspections and testing as necessary to determine compliance with the Construction Documents. Perform special inspections in a timely manner to avoid delay of work.

The Approved Agency shall be responsible to insure that any non-local inspection/testing agency fully complies with this Section and the SSI.

3-2.03. Defective Work. Immediately notify Contractor of the need for corrective action when work does not conform to Construction Documents.

3-2.04. Uncorrected Defective Work. Notify the AHJ and RDPRC when deficiencies have not been corrected. Notice will be made prior to the completion of that phase of the work.

3-2.05. Interim Inspection Reports. Furnish interim inspection reports to the AHJ, the RDPRC, Contractor, Engineer, and Owner during the progress of the work. Frequency of reports will be as established in the SSI. Reports will indicate that work inspected was done in conformance to the approved Construction Documents, or that the work was defective, as applicable.

Special inspection reports and test results will include, but not be limited to, the following:

Project name and address.

Permit number.

Special Inspection Agency name, address, and phone number.

Unique identification of the report and of each page.

Date and time of inspection.

Description of inspections or tests performed, including item description and location (reference grid lines, floors, elevations, etc.). Identify approved agencies employed to carry out tests.

Identification of test/inspection equipment used.

Statement noting that the work, material, and/or product conforms or does not conform to the construction document requirements. Describe defective items.

Name and signature of Contractor's representative who was notified of work, material, and/or products that do not meet the construction document requirements.

Name and signature of Special Inspector and/or testing agency representative performing the work.

3-2.06. Report of Defective Work. Each agent will maintain a log that identifies work that does not meet the requirements of the construction documents. Include:

Description and exact location.

Reference to applicable drawings and specifications.

Reference to original inspection/test report and subsequent dates of re-inspection/retesting.

Name and title of each individual notified and method of notification.

How defective items were resolved or unresolved, as applicable.

Itemized changes authorized by the RDPRC and AHJ if not included in a defective item.

3-2.07. Submittal Schedule. Documentation of reports, test results, and non-compliant work will be submitted at the frequency indicated in the SSI.

3-2.08. Final Report of Special Inspections. Each agent listed in the SSI shall submit a final report to the Approved Agency documenting the performed special inspections and the correction of any discrepancies noted. The Approved Agency shall cumulate the reports and submit a comprehensive final report at a point in time as agreed upon by the permit applicant and the AHJ prior to the start of work.

Statement of Special Inspections

Project:
Project Address:
Permit Applicant:
Applicant Address:
Owner:
Owner Address:

Registered Design Professional in Responsible Charge (RDPRC) :

Discipline	Name	License Number	Expiration Date
Structural Engineer			
Geotechnical Engineer			
Mechanical Engineer			
Electrical Engineer			
Architect			

This Statement of Special Inspections includes a *Schedule of Special Inspections* applicable to the above referenced project as well as the identity of the individuals, agencies, or firms intended to be retained for conducting these inspections.

The Special Inspector(s) shall keep records of all inspections and shall furnish interim inspection reports to the Authority Having Jurisdiction (AHJ) and to the Registered Design Professional in Responsible Charge (RDPRC). Discrepancies shall be brought to the immediate attention of the Contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the AHJ and the RDPRC prior to completion of that phase of work. A *Final Report of Special Inspections* documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted by each agent.

The Special Inspection program does not relieve the Contractor of the responsibility to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

Inspection work shall be performed in accordance with the following codes and standards. Unless otherwise indicated within the Statement of Special Inspections, the applicable edition for all codes and standards shall be as follows.

Work	In Accordance With
Building Code	2012 International Building Code (IBC)
Seismic Criteria for Nonstructural Components	ASCE 7-10
Standard Tests and Practices	Listed American Society for Testing and Materials (ASTM) specifications
Concrete	ACI 318-11 and ACI 350-06
Masonry	ACI 530-11 and ACI 530.1-11

Work	In Accordance With
Structural Steel	AISC 360-10 and AISC 341-10
Structural steel welding	AWS D1.1 Structural Welding Code - Steel
Aluminum welding	AWS D1.2 Structural Welding Code – Aluminum
Sheet steel welding	AWS D1.3 Structural Welding Code – Sheet Steel
Structural steel bolting	Research Council on Structural Connections Specification for Structural Joints Using High Strength Bolts, December 31, 2009
Intumescent Fire-Resistive Coating	Association of the Wall and Ceiling Industry (AWCI) Technical Manual 12-B, Second Edition; Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials; an Annotated Guide

RDPRC - Structural	RDPRC - Civil/Geotechnical	RDPRC - Mechanical
RDPRC – Electrical	RDPRC - Architect	

Owner's Acknowledgement:

Signature Date

Acceptance by Authority Having Jurisdiction:

Signature Date

Permit No.

Frequency of interim report submittals to AHJ:

☐ 1 week ☐ 2 weeks ☐ Monthly ☐ Bi-Monthly ☐ At Completion ☐ Per attached Schedule

Statement of Special Inspections
(Schedule of Inspections)

The attached tables as listed below define the applicable Special Inspections and Procedures.

Table 1 of 9	Geotechnical Special Inspections
Table 2 of 9	Structural Special Inspections
Table 3 of 9	Architectural Special Inspections
Table 4 of 9	Inspections for Special Cases
Table 5 of 9	Testing for Special Inspections
Table 6 of 9	Special Inspections for Seismic Resistance
Table 7 of 9	Testing and Qualification for Seismic Resistance
Table 8 of 9	Special Inspections for Wind Resistance
Table 9 of 9	Inspection Agents

The Seismic Design Category for the project is (C).

The nominal design wind speed, V_{asd}, for the project is 72 mph (3 second gust) and the wind exposure category is (C).

Schedule of Special Inspections - Table 1 of 9 (Geotechnical Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Soils						
Verify material below foundation is adequate to achieve design bearing capacity, free of loose, deleterious or foreign material.	1705.6	Geotechnical Report		**X** (foundation excavation complete)	IC Transfer Pump Station SR Primary Clarifiers All Junction and Distribution Boxes Primary Headhouse Retainin Walls	
Verify excavations are extended to proper depth, proper size and material.	1705.6	Geotechnical Report		**X** (foundation excavation complete)	IC Transfer Pump Station SR Primary Clarifiers All Junction and Distribution Boxes Primary Headhouse Retainin Walls	
Prior to placement of controlled fill, observe subgrade and verify site is properly prepared.	1705.6	Geotechnical Report		**X** (prior to placement of fill)	IC Transfer Pump Station SR Primary Clarifiers All Junction and Distribution Boxes Primary Headhouse Retainin Walls	
Perform classification and testing of compacted fill material.	1705.6	Geotechnical Report		**X** (during placement of fill)		
Verify materials, densities, and lift thicknesses during placement and compaction of controlled fill for foundations.	1705.6	Geotechnical Report	**X**		Note the exception of Article 1705.6.	

Schedule of Special Inspections - Table 1 of 9 (Geotechnical Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Installation: Location, plumbness, diameters, bell diameter, lengths, embedment into bedrock, adequate end bearing strata capacity, record of concrete or grout volumes.	1705.8	Geotechnical Report	X			
Mechanically Stabilized Earth (MSE) Retaining Walls						
Installation: modular unit product name, type, and dimensions, foundation preparation, modular unit placement, including alignment and inclination, geosynthetic reinforcement product name, type, and placement, backfill placement and compaction, and drainage provisions.	1703.4 1705.1.1.3	Geotechnical Report and Manufacturer's research reports	X			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Structural Load-Bearing Members Fabricated in a Shop						
Verification of detailed fabrication and quality control procedures including review for completeness and adequacy relative to the code requirements.	1704.2.5.1			**X** (prior to start of fabrication)		
If registered and approved by the AHJ to perform work without special inspection, submit "Fabricator's Certificate of Compliance" at the completion of work that fabricated items were constructed in accordance with the approved construction documents.	1704.2.5.2			**X** (at end of fabrication)		N/A
Concrete (inspections not required for nonstructural concrete slabs supported directly on the ground)						
Reinforcing steel and prestressing tendon condition (free of oil, dirt and loose rust and that properly coated and/or sheathed) and placement. Verify size, spacing, bar clearances, cover, and adequate support to prevent displacement during concrete placement. Verify lap splices, mechanical splices, and embedment lengths. Verify dowels for work above are properly aligned and spaced to match other work.	1705.3	ACI 318 (3.5) ACI 318 (7.1-7.7)		**X** (prior to closing of forms or delivery of concrete, for each placement)		
Cast-in-place anchor bolts prior to and during placement of concrete.	1705.3	ACI 318 (Appendix D)	**X**		All bolts visually inspected to verify anchor diameter, location, and embedment length.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Verify use of approved mix design(s).	1705.3 1904.1	ACI 318 (Ch. 4) ACI 318 (5.2-5.4)		**X**	RDPRC to approve contractor's proposed mix design prior to construction. Inspector to verify from concrete delivery ticket that the appropriate mix has been provided prior to placement.	
Formwork shape, location, and dimensions of the concrete member being formed, construction joints properly prepared.	1705.3	ACI 318 (6.1.1)		**X** (prior to delivery of concrete for each placement)		
At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content test, and determine the temperature of the concrete.	1705.3	ASTM C31 ASTM C172 ACI 318 (5.6)		**X**	Sampling and testing frequency shall be as indicated in the cast-in-place concrete specification.	
Concrete placement.	1705.3	ACI 318 (5.9-5.10)	**X**		Verify that water added at the site does not exceed that allowed by the mix design. Verify conveying, depositing, and consolidation of concrete. Observe placement procedures for evidence of segregation, possible cold joints, displacement of reinforcing or forms, and proper support of embedded items, anchor bolts, etc.	
Concrete curing – maintain temperature and techniques.	1705.3	ACI 318 (5.11-5.13)		**X** (during hot, cold, and windy conditions)	For wet-curing, check at the beginning of each day during 7 day curing period	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Verification of in-situ concrete strength prior to removal of forms and shores from elevated beams and slabs.	1705.3	ACI 318 (6.2)		**X** (prior to form or shore removal)		
Verification of in-situ concrete strength prior to backfilling against walls.				**X** (prior to backfilling operations)		
Masonry for Occupancy Category I, II, or III Structures						
Verification of proportions for site-prepared mortar and grout.	1705.4	ACI 530 (1.19.2.2) ACI 530.1 (2.1) ACI 530.1 (2.6A) ACI 530.1 (2.6B)		**X** (at beginning of masonry construction and prior to grouting)		
Verification of proportions for site-prepared prestressing grout for bonded tendons.	1705.4	ACI 530.1 (2.4G.1.b) ACI 530.1 (2.6B)		**X** (at beginning of masonry construction and prior to grouting)		
Verification of proportions of materials in premixed or preblended mortar and grout as delivered to the site.				**X** (at beginning of masonry construction and prior to grouting)	RDPRC to approve contractor's proposed mix designs prior to construction. Inspector to verify from grout delivery ticket that the appropriate mix has been provided prior to placement.	
Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	1705.4	ACI 530.1 (1.5B.1.b.3)	**X**			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Verification of f'_m and f'_{AAC} prior to construction and for every 5000 square feet during construction.	1705.4	ACI 530.1 (1.4B)		**X**	Verification by unit strength or prism testing, see masonry specification.	
Placement of masonry units and mortar joint construction.	1705.4	ACI 530.1 (3.3B)		**X** (at beginning of masonry construction, once daily for each crew, and prior to grouting)	Inspect size, layout, bonding and placement of masonry units. Inspect construction of mortar joints including tooling and filling of head joints.	
Type, grade, and size of prestressing tendons and anchorages.	1705.4	ACI 530.1 (2.4B) ACI 530.1 (2.4H)		**X** (when staged and prior to installation)		
Verification of size and location of structural elements.	1705.4	ACI 530.1 (3.3F)		**X** (at beginning of masonry construction and prior to grouting)		
Anchors grouted in masonry and anchorage of masonry to frames, structural members, and diaphragms including type, size, and location of anchors.	1705.4	ACI 530 (1.17.1)		**X** (at beginning of masonry construction and prior to grouting)		
Type, grade, and size of reinforcing steel.	1705.4	ACI 530 (1.16) ACI 530.1 (2.4) ACI 530.1 (3.4)		**X** (when staged and prior to installation)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No**. (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Verify grout space is clean prior to grouting.	1705.4	ACI 530.1 (3.2D) ACI 530.1 (3.2F)		**X** (prior to each grouting operation)	Verify that cells and starting beds are clean.	
Reinforcing steel and connector placement: verify size, spacing, surface condition, correct location, type of embedments.	1705.4	ACI 530 (1.16) ACI 530.1 (3.2E) ACI 530.1 (3.4)		**X** (at beginning of masonry construction and prior to grouting)	Verify dowels and inserts are secured in place, particularly at roof lines, floor lines, and intersecting wall lines.	
Grout placement.	1705.4	ACI 530.1 (3.5)	**X**		Verify that the grout lift height is in conformance with the code and specifications. Verify installation of cleanout closures. Verify that grouting operations are held below the top if keying is required for subsequent lifts, as required by code and specifications. Verify mechanical vibration during placement, and later during reconsolidation. Verify that curing requirements are being followed.	
Cold/hot weather masonry protection.	1705.4 2104.3 2104.4	ACI 530.1 (1.8C) ACI 530.1 (1.8D)		**X** (at beginning of each day's work)	When temperatures are expected to be below 40 degrees F or above 90 degrees F.	
Observe preparation of required grout specimens, mortar specimens, and/or prisms.	1705.4 2105.2.2 2105.3	ACI 530.1 (1.4)		**X**	Verification by unit strength or prism testing, see masonry specification.	
Steel						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Material verification of high strength bolts: Identification markings to conform to specified ASTM standards.	1705.2.1	Applicable ASTM material specifications AISC 360 (A3.3) AISC 360 (N3)		**X** (3 bolts from each lot)	Verified at jobsite.	
Material verification of high strength bolts: Manufacturer's certificate of compliance.	1705.2.1	AISC 360 (A3.3) AISC 360 (N3)		**X** (each lot)		
Material verification of structural steel: Identification markings to conform to specified ASTM standards.	1705.2.1 2203.1	AISC 360 (A3.1) AISC 360 (N3)		**X** (3 pieces from each lot)	Verified at fabricator's shop prior to cutting.	
Material verification of structural steel: Certified mill test reports.	1705.2.1 2203.1	AISC 360 (A3.1) AISC 360 (N3)		**X** (each mill order)		
Material verification of anchor rods and threaded rods: Manufacturer's certified test reports.	1705.2.1	AISC 360 (A3.4) AISC 360 (N3)		**X** (each lot)		
Material verification of welding consumables: Identification markings to conform to specified AWS standards.	1705.2.1	AISC 360 (A3.5) AISC 360 (N3) AWS A5 documents		**X** (3 rods from each lot)	Verified at fabricator's shop and at jobsite.	
Material verification of welding consumables: Manufacturer's certificate of compliance.	1705.2.1	AISC 360 (A3.5) AISC 360 (N3) AWS D1.1 (6.2)		**X** (each lot)		
Verify use of proper WPS's.	1705.2.1	AISC 360 (N3) AWS D1.1 (6.3)		**X** (prior to start of work)	Obtain copy of welding procedure specifications.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Verify welder qualifications.	1705.2.1	AISC 360 (N3) AWS D1.1 (6.4)		**X** (prior to start of each welder's work)	Obtain copy of qualification records.	
Complete and partial penetration groove welds.	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**		Inspect pre-heat, post-heat and surface preparation between passes.	
Multipass fillet welds.	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**		Inspect pre-heat, post-heat and surface preparation between passes.	
Single pass fillet welds greater than 5/16".	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**			
Plug and slot welds.	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**			
Single pass fillet welds less than or equal to 5/16".	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No**. (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Welding stair and railing systems.	1705.2.1	AWS D1.1 (Section 6.9)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		
Observe high strength bolt preinstallation testing and calibration procedures.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 7)		**X** (3 complete fastener assemblies of each combination of diameter, length, grade, and lot to be used in the work)	Test in a tension calibrator at the site. Required pretension is equal to or greater than 1.05 times that specified for installation. Verify accuracy of the tension calibrator has been confirmed through calibration within previous 12 months.	
Snug-tight high strength bolt installation: All connections visually inspected. Connected materials drawn together and properly snugged.	1705.2.1	AISC 360 (M2.5) AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9)		**X** (observe once daily for each bolting crew and at completion of assembly installation)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Pretensioned high strength bolt installation using turn-of-the-nut method with match marking, direct tension indicator method, or twist-off type tension control bolt method: Verify installation procedure, all plies drawn together and properly snugged, visually inspect all connections. Verify that splines have separated from tension control bolts.	1705.2.1	AISC 360 (M2.5) AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9)		**X** (observe once daily for each bolting crew and each assembly installation as noted in Remarks)	Turn-of-the-nut method with match marking: after pretensioning. Direct tension indicators: feeler gauge used after snugging and after pretensioning. Twist-off type tension control bolt: after pretensioning.	
Pretensioned high strength bolt installation using turn-of-the-nut method without match marking or calibrated wrench method: Verify installation procedure, all plies drawn together and properly snugged, visually inspect all connections.	1705.2.1	AISC 360 (M2.5) AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9)	**X**			
Verification of frame joint details including application, component locations, bracing, and stiffening, proper application of joint details at each connection.	1705.2.1	AISC 360 (N5.7)		**X** (at 50% complete and 100% complete, for each structure)		
Proprietary moment resisting frame connection systems.	1703.4.2				Refer to welding and high strength bolting requirements.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Cold-Formed Steel Framing						
Material verification of weld filler metals: Identification markings to conform to specified AWS standards.	1705.2.2.1.1	AWS D1.3 (Section 6)		**X** (3 rods from each lot)	Checked at fabricator's shop and at jobsite.	
Material verification of welding consumables: Manufacturer's certificate of compliance.	1704.2.2.1.1	AWS D1.3 (Section 6)		**X** (each lot)		
Verify use of proper WPS's.	1704.2.2.1.1	AWS D1.3 (Section 6)		**X** (prior to start of work)	Obtain copy of welding procedure specifications.	
Verify welder qualifications.	1705.2.2.1.1	AWS D1.3 (Section 6)		**X** (prior to start of each welder's work)	Obtain copy of qualification records.	
Welded framing connections.	1704.2.2.1.1	AWS D1.3 (Section 6)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Post-Installed Anchors – Expansion and Undercut Anchors into Concrete						
Verify anchor type, size, dimensions, location, spacing, edge distance, drill bit type, drill bit diameter, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		**X**	Continuous inspection is required if mandated by manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Concrete						
Adhesive anchors installed in overhead, upwardly inclined, or horizontal positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report	**X**			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Adhesive anchors installed in other positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		X	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection.	
Post-Installed Anchors – Expansion Anchors into Grouted Masonry						
Verify anchor type, size, dimensions, location, spacing, edge distance, drill bit type, drill bit diameter, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, mortar type, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		X	Continuous inspection is required if mandated by the manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Grouted Masonry						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		**X**	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection. Continuous inspection is required if mandated by the manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Hollow Masonry						
Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, screen tube type and size, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		**X**	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection. Continuous inspection is required if mandated by the manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Unreinforced Brick Masonry						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No**. (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry thickness, screen tube type and size, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report	**X**			
Aluminum						
Material verification of structural aluminum: Certified mill test reports.	1705.1.1			**X** (each mill order)		
Material verification of bolts: Manufacturer's certified test reports.	1705.1.1			**X** (each lot)		
Material verification of weld filler metals.	1705.1.1	AWS D1.2 (Section 5)		**X** (3 rods from each lot)	Checked at fabricator's shop and at jobsite.	
Verify use of proper WPS's.	1705.1.1	AWS D1.2 (Section 5)		**X** (prior to start of work)	Obtain copy of welding procedure specifications.	
Verify welder qualifications.	1705.1.1	AWS D1.2 (Section 5)		**X** (prior to start of each welder's work)	Obtain copy of qualification records.	
Complete and partial penetration groove welds.	1705.1.1	AWS D1.2 (Section 5)	**X**			
Multipass fillet welds.	1705.1.1	AWS D1.2 (Section 5)	**X**			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Single pass fillet welds.	1705.1.1	AWS D1.2 (Section 5)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		

Schedule of Special Inspections - Table 3 of 9 (Architectural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		

Schedule of Special Inspections - Table 4 of 9 (Inspections for Special Cases)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Pre-Engineered Structures						
Fabrication and erection	1705.1.1				Refer to Table 2 for fabricator, welding, and high strength bolting special inspection requirements	
Mass Concrete Procedures						
Thermal monitoring plan				**X**	See mass concrete specification for thermal monitoring plan requirements	
Curing and heat removal methods				**X**	See mass concrete specification for curing and heat removal requirements.	
Construction joints			**X** Verify joint locations match the Thermal Control Plan		See mass concrete specification for construction joint requirements.	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Inspection				
	Building Code Reference	Code or Standard Reference	Frequency	Remarks	Inspection Agent No. (see Table 9)
System or Material					
Geotechnical					
Classification of controlled fill material.	1705.6	ASTM D2488	One per stratum of on-site excavated material. One per common supply of off-site material.	Per Geotechnical Report and excavation and fill for structures specification.	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No.** (see Table 9)
Foundation subgrade, in-place density.	1705.6	ASTM D2922 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 1,000 SY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	Per Geotechnical Report and excavation and fill for structures specification.	
Controlled fill beneath foundations, in-place density.	1705.6	ASTM D2922 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 200 CY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	Per Geotechnical Report and excavation and fill for structures specification.	
Concrete					
Concrete strength.	1705.3	ASTM C31 ASTM C39 ASTM C172	See concrete specification	See concrete specification for quantity of cylinders.	
Concrete slump, air content, temperature, unit weight, water soluble chloride ion, shrinkage.	1705.3	ASTM C31 ASTM C138 ASTM C143 ASTM C157 ASTM C172 ASTM C231 ASTM C1064 ASTM C1218	See concrete specification		

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No.** (see Table 9)
Steel					
Liquid penetrant (PT), magnetic particle (MT), radiographic (RT) and ultrasonic (UT) testing of welds.	1705.2	PT – AWS D1.1 (6.10 & 6.14.5) MT - AWS D1.1 (6.10 & 6.14.4) RT – AWS D1.1 (6.12 & 6.14.1) UT - AWS D1.1 (6.13 & 6.14.3)			
Pre-construction testing of welding studs.	1705.2	AWS D1.1 (7.7.1)	Each size and type of stud each shift		
Welding studs.	1705.2	AWS D1.1 (7.8)	All questionable studs not showing full 360° flash. Randomly test all other studs as noted: - 15% of studs welded thru deck - 5% of studs welded to bare steel	Test by bending studs to 15° from vertical, away from weld discontinuity. All ceramic welding ferrules shall be removed by Contractor.	
Aluminum					
Liquid penetrant (PT) and radiographic (RT) testing of welds.		PT - AWS D1.2 (5.7.5) RT - AWS D1.2 (5.10 & 5.15)		Critical welds to be tested at a rate of 10 percent for fillet welds and 100 percent for more complex welds such as CJP and PJP groove welds, multipass fillet welds, single pass fillet welds larger than 5/16, and plug/slot welds.	

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (see Table 9)
Steel (shop inspection is not required when work is done by a pre-approved fabricator)						
Visually inspect the following before welding: material type and grade; welder identification system; fit up of groove welds including joint preparation, dimensions, cleanliness, tacking, backing type and fit; configuration and finish of access holes; fit up of fillet welds including dimensions, cleanliness and tacking.	1705.11.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect during welding: WPS followed, use of qualified welders, control and handling of welding consumables, environmental conditions, welding techniques, no welding over cracked tacks.	1705.11.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect after welding: Welds cleaned, size, length, and location of welds.	1705.11.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No**. (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Visually inspect welds after welding to acceptance criteria for: crack prohibition, weld/base metal fusion, crater cross section, weld profile, weld size, undercut, and porosity.	1705.11.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
Visually inspect welds after welding for placement of reinforcement fillets, removal of backing bars and weld tabs and finish (where required on drawings or per specifications), and repair activities.	1705.11.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
Prior to high strength bolting: verify proper fasteners and bolting procedures selected for the detail, connecting elements fabricated properly including faying surface preparation and hole preparation, proper storage for bolts, nuts, washers and other components.	1705.11.1	AISC 341 (J7)		**X** (Once daily for each bolting crew)		
During high strength bolting: Fasteners assemblies properly positioned, joints snug tight prior to pretensioning, fastener component not turned by the wrench prevented from rotating, pretensioning progresses systematically from most rigid point to free edges.	1705.11.1	AISC 341 (J7)		**X** (observe once daily for each bolting crew)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No**. (see Table 9)
After installation of high strength bolting, document accepted and rejected connections.	1705.11.1	AISC 341 (J7)		**X** (at completion of each connection)		
Mechanical Components (Required only for Seismic Design Categories C, D, E, and F. Non-applicable rows should be removed.)						
Installation of equipment and piping for flammable, combustible, or highly toxic materials and associated mechanical units.	1705.11.6			**X** (observe once daily for each crew and completed installation of each applicable piece of equipment and piping)		
Installation of HVAC equipment and ductwork containing hazardous materials and anchorage of such ductwork.	1705.11.6			**X** (observe once daily for each crew and completed installation of each applicable piece of equipment)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No**. (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Vibration isolation systems and their anchorage, where nominal clearance between equipment and support frame and restraint is 0.25 inches or less.	1705.11.6			**X** (observe once daily for each crew and completed installation of each applicable piece of equipment)		
Electrical (Required for Seismic Design Categories C, D, E, and F, except as noted otherwise)						
Anchorage of electrical equipment for emergency and standby power.	1705.11.6			**X** (observe completed installation of each applicable piece of equipment)	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components that must be anchored.	

Schedule of Special Inspections - Table 7 of 9 (Testing and Qualification for Seismic Resistance)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No.** (see Table 9)
Steel (testing is not required when work is done in the shop of a pre-approved fabricator)					
Ultrasonic (UT) of base metal thicker than 1-1/2" subject to through-thickness weld shrinkage strains. Test is for discontinuities behind and adjacent to each weld.	1705.12.2	AWS D1.1(6.13 & 6.14.3)	Each weld		
When welding doubler, continuity, or stiffener plates in the k-area of a web, test the web for cracks using magnetic particle testing (MT).	1705.12.2	AISC 341 (J6.2)	Each plate location	Inspection area shall include the k-area base metal within 3 inches of the weld. Testing shall be performed no sooner than 48 hours following completion of the welding.	
For CJP groove welds in material 5/16” thick and greater, perform ultrasonic testing (UT).	1705.12.2	AISC 341 (J6.2)	Each weld	Weld discontinuities shall be accepted or rejected on the basis of critiera of AWS D1.1 Table 6.2. In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for possible reduction in testing frequency.	
For beam to column CJP groove welds, perform magnetic particle testing (MT).	1705.12.2	AISC 341 (J6.2)	25% of all such welds for each welder	In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for permitted reduction in testing frequency.	
When base metal thicker than 1-1/2" is loaded in tension in the through-thickness direction in tee and corner joints, where the connected material is greater than 3/4” thick and contains CJP welds, perform ultrasonic testing (UT) to detect discontinuities behind and adjacent to the fusion line of each weld.	1705.12.2	AISC 341 (J6.2)	Each weld	See AISC 341 for permitted reduction in testing frequency.	

Schedule of Special Inspections - Table 7 of 9 (Testing and Qualification for Seismic Resistance)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No**. (see Table 9)
For welded splices and connections, perform magnetic particle testing (MT) or liquid penetrant testing (PT) at thermally cut surfaces of beam copes and access holes when the flange thickness exceeds 1-1/2” for rolled shapes or the web thickness exceeds 1-1/2” for built-up shapes.	1705.12.2	AISC 341 (J6.2)	Each weld		
For welds where weld tabs have been removed, except for continuity plate weld tabs, perform magnetic particle testing (MT) on the ends of the weld.	1705.12.2	AISC 341 (J6.2)	Each weld or location	See AISC 341 for permitted reduction in testing frequency.	
Pre-installation testing of fastener assemblies and methods used.	1705.12.2	AISC 341 (J7) RCSC Specification for Structural Joints Using High Strength Bolts (Section 7)	3 assemblies of each diameter, grade, length, and lot prior to use		
Non-Structural Components (Architectural, Mechanical and Electrical)					
For non-structural components and their anchorage that are qualified by means of testing, examine the certificate of compliance furnished by the product manufacturer.	1705.12.3	ASCE 7 (13.2.5)	Each applicable piece of equipment	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components and their anchorages that must be qualified.	

Schedule of Special Inspections - Table 8 of 9 (Special Inspections for Wind Resistance)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (See Table 9)

Schedule of Special Inspections - Table 9 of 9 (Inspection Agents)					
AGENT NAME	**LICENSE NO.**	**FIRM**	**ADDRESS**	**EMAIL**	**TELEPHONE NO.**
1.					( )
2.					( )
3.					( )
4.					( )
5.					( )
6.					( )
7.					( )
8.					( )
9.					( )
10.					( )

Request for Approval of Special Inspector

Project:
Project Address:
Name of Inspection/Testing Agency:
Address:
Phone Number:
Testing agency manager/supervisor responsible for this project:

Special Inspector Name:

Special Inspector Signature: _____
(as it will appear on reports)

This individual is qualified to inspect:

[ ] Verification of Soils
[ ] Earth Retaining Structure
[ ] Excavation and Filling
[ ] Piling
[ ] Drilled Piers
[ ] Testing of Concrete
[ ] Placement of Concrete
[ ] Placement of Shotcrete
[ ] Placement of Rebar
[ ] Prestressing Concrete
[ ] High Strength Bolting
[ ] Structural Welding
[ ] Steel Frame Inspection
[ ] Structural Masonry
[ ] Erection of Precast
[ ] Inspection of Fabricators
[ ] Precast Fabrication
[ ] Structural Steel
[ ] Metal Building
[ ] EIFS Inspection
[ ] Smoke Control
[ ] Seismic Resistance
[ ] Sprayed Fireproofing
[ ] Architectural Systems
[ ] Mechanical Systems
[ ] Electrical Systems

Current certifications and/or professional licenses retained by the individual:

[ ] Professional Engineer
[ ] Geotechnical Engineer
[ ] Structural Engineer
[ ] Registered Architect
[ ] Registered Geologist
[ ] EI/EIT (min. of 1 yr. related experience)
[ ] GIT (min. of 1 yr. related experience)
[ ] ACI Concrete Field Testing Technician Grade 1
[ ] ACI Concrete Construction Inspector
[ ] ACI Laboratory Testing Technician, Grade 1 or 2
[ ] ACI Strength Testing Technician
[ ] AWS Certified Welding Inspector
[ ] AWS/AISC Certified Structural Steel Inspector
[ ] ASNT NDT Technician Level II or III
[ ] ICC Building Inspector
[ ] ICC Structural Masonry
[ ] ICC Structural Steel and Welding
[ ] ICC Spray-Applied Fire Proofing
[ ] ICC Prestressed Concrete
[ ] ICC Reinforced Concrete
[ ] ICC Structural Steel and Bolting
[ ] ICC Structural Welding
[ ] NCMA Concrete Masonry Testing Technician
[ ] NICET Concrete Technician Level II, III, or IV
[ ] NICET Soils Technician Level II, III, or IV
[ ] NICET Geotechnical Engineering Technician Level II, III, or IV
[ ] EDI EIFS
[ ] Other _____

Copies of current certifications and/or professional licenses and a resume showing the special inspector's work experience are attached.

I hereby certify that in my judgment the individual is qualified to inspect and/or test the items indicated above.

Special Inspection Agency:

Signed:_____Date:_____
(Testing agency manager/supervisor responsible for this project)

Request for Approval to Provide Special Inspection of Non-Local Fabrication

Project:
Project Address:

Testing / Inspection Agent:
Testing / Inspection Agent Address:
Scope of Testing / Inspections:

We propose to have the following testing agency provide special inspection of fabrication of:

Fabricator name:
Fabricator address:

Name of Testing Agency:
Address:
Phone Number:
Testing agency manager/supervisor responsible for this project:
Primary special inspector for this project:

Copies of the Request for Approval of Special Inspector, resumes, and certifications are attached.

The fabrication inspections to be performed are:

The undersigned hereby acknowledge that they have read, understand and will properly enforce the inspection and testing requirements for the above referenced project, as specified in the Code-Required Special Inspections and Procedures section. Further, the undersigned acknowledge that they have no interest (financial, personal or otherwise) in the performance or management of the above identified Fabricator.

Signature of Primary Special Inspector	Date
Signature of Responsible Agency Manager/Supervisor	Date
Signature of Responsible Manager for Approved Agency employed by the Owner	Date

Contractor's Statement of Responsibility

Each Fabricator, Contractor, or Supplier responsible for the construction or fabrication of a system or component designated in the Statement of Special Inspections shall submit this Statement of Responsibility.

Project:
Contractor's or Supplier's Name:
Address:
License No.:

Description of designated building systems and components included in the Statement of Responsibility:

Acknowledgment of Special Requirements

I hereby acknowledge that I have received, read, and understand the Code Required Special Inspections and Tests program and the Schedule of Special Inspections.

I hereby acknowledge that control will be exercised to obtain conformance with the construction documents approved by the Authority Having Jurisdiction.

Signature _____ Date _____

Title _____

Provisions for Quality Control

Procedures for exercising control within the Fabricator's, Contractor's, or Supplier's organization, the method and frequency of reporting and the distribution of reports are attached to this Statement.

Identification and qualifications of the person(s) exercising such control and their position(s) in the organization are attached to this Statement.

Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per the governing building code shall submit this *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project:
Fabricator's Name:
Address:
Certification or Approval Agency:
Certification Number:
Date of Last Audit or Approval:

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with the approved construction documents.

Signature _____ Date _____

Title _____

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

Final Report of Special Inspections

Project:
Project Address:

Testing / Inspection Agent:
Testing / Inspection Agent Address:
Scope of Testing / Inspections:

To the best of my information, knowledge, and belief, the special inspections or testing required for this project, and designated for this Agent in the Statement of Special Inspections submitted for permit, have been completed in accordance with the contract documents. Based upon my personal observations and written reports, it is my judgment that the inspected work was performed, to the best of my knowledge, in accordance with the building department approved design drawings, specifications, approved change orders, and applicable workmanship provisions of the governing building code.

Interim reports submitted prior to this final report and numbered _____ to _____, form a basis for, and are to be considered an integral part of this final report.

The following discrepancies that were outstanding since the last interim report dated
have been corrected:

Items not in conformance, unresolved items or any discrepancies in inspection coverage (i.e., missed inspections, periodic inspections when continuous was required, etc.) are as follows:

Prepared By:

Type or print name

Signature Date

Special Inspector's Seal

(Licensed Professional)

SECTION 01500

TEMPORARY FACILITIES

PART 1 - GENERAL

1-1. SCOPE.

1-1.01. The work covered under this Section includes furnishing all labor, equipment, and materials required to furnish and install temporary facilities and accessories, as shown on the Drawings and specified herein. The Contractor shall provide all temporary facilities necessary for the proper completion of the Work, as necessary and as specified.

1-1.02. The Contractor shall maintain temporary facilities in proper and safe condition through the progress of the Work. In the event of loss or damage, the Contractor shall immediately make all repairs and replacements necessary subject to approval of the Engineer and at no additional cost to the Owner. At completion of the Work, remove all such temporary facilities or as directed by the Engineer.

1-1.03. All of the office furnishings and equipment provided by the Contractor for the Engineer's facilities under this Section shall remain as property of the Owner.

1-1.04. All expenditures for furnishing, installation, maintenance, and recurring costs of temporary facilities, office furnishings, office electrical equipment, various hardware and software, lines, line extensions, and installation of utility service shall be paid by the Contractor and included in Item No. 1 of the Base Bid.

1-2. REQUIREMENTS.

1-2.01. General. The materials, equipment, and furnishings provided under this Section shall be new, and shall meet all the applicable codes and regulations.

The Contractor shall make all provisions, and pay all costs of furnishing, installation, maintenance, professional services, permit fees, and site work for the temporary facilities.

1-2.02. Construction. Temporary buildings shall be structurally sound, weather tight, with floors raised above ground. All mobile/modular buildings shall comply with GA-DCA/SBCC/ADA requirements, and shall be Williams-Scottsman or equal.

Temporary buildings shall have temperature transmission resistance compatible with occupancy and storage requirements.

1-3. SUBMITTALS.

1-3.01. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Construction Facilities Plan for each work site for approval by the Engineer.
2. Shop drawings of all signs prior to their manufacture and erection.
3. Copy of the Contractors proposed wheel washing stations in the event the Engineer determines their deployment is necessary.

1-4. CONTRACTOR'S FACILITIES.

1-4.01. The shall propose the area to be used as the main staging area for the Contractor's operations. Any additional staging that the Contractor may require shall be identified in the Facilities Plan and provided by the Contractor at no additional cost to the Owner. The Facilities Plan shall include narrative of the mobilization, site preparation, and the schedule for each site of the Work.

1-4.02. Contractor's Facilities: The Contractor shall submit a plan of the plant layout to the Engineer for approval within fifteen (15) days of the Notice to Proceed. The Contractor's Facilities, for purposes of this Section, is defined to include but not limited to its field offices, first aid station, and storage facilities. Sufficient construction plant shall be provided and maintained at all points where work is in progress to meet adequately the demands of the Work and with ample margin for emergencies or overload.

1-4.03. The Facilities shall be of sufficient capacity and reliability to permit a rate of progress, which will insure completion of the Work within the time stipulated in the Contract. Insufficient, inadequate, improper Facilities, or equipment shall be brought to acceptable condition or shall be removed from the site of the Work.

1-4.04. The location of stationary and mobile equipment shall be subject to the Engineer's approval.

1-4.05. First Aid Stations: The Contractor shall provide a suitable first aid station at each work site. Each station shall be equipped with all facilities and medical supplies necessary to administer emergency first aid treatment. The Contractor shall have standing arrangements for the removal and hospital treatment of any injured person. The information reflecting this arrangement shall be clearly posted for easy visibility. All first aid facilities and emergency ambulance services shall be made available by the Contractor to the Owner's and Engineer's personnel.

1-4.06. The Contractor shall be wholly responsible for the security of the site office and storage compound and for all its plant, materials, equipment, and tools at all times.

1-4.07. The Contractor shall make all arrangements for all utilities and shall be responsible for maintaining all utilities, including all Engineer's Facility utility services, at

no additional cost to the Owner. In areas where connections to local sewer systems are not practical, the Contractor shall install and maintain sewage holding tank systems.

These sewer systems must be equipped with a means of monitoring and preventing overflows. The Contractor shall remove the systems at the end of construction at no additional cost to the Owner.

1-5. ENGINEER'S FACILITIES.

1-5.01. Engineer's Field Office. Within 90 days after receipt of the Notice to Proceed construct, paint, and furnish all materials and equipment and maintain Engineer's Field Office at the Intrenchment Creek WRC Site or the South River WRC Site as directed by the Engineer.

Furnish equipment specified under this article for the exclusive use of Engineer and its representatives.

The Contractor shall provide one 60-foot-long double-wide trailer to serve as the Site Office for the Owner's and Engineer's field staff at the location specified under 1.05.A.1. The interior of the trailer shall be divided by partitions with doors and have a minimum of 6 offices, one conference room, copier room, supply room, a men's and women's restroom. Dimensions for all rooms shall be determined by the Engineer. The size and number of storage closets shall be as directed by the Engineer. All closets and partition doors shall be furnished with integral locks

The office shall have at least two exterior entries with solid core doors with deadbolts and a covered porch at least 6 feet square at each entrance.

The Engineer will indicate the locations of telephone/computer outlets and certain electrical outlets on the modular office shop drawing. However, there shall be a minimum of one-combination telephone/computer outlets per office including, the conference room and all shall be wired to the communication's closet

Electrical outlets are to be no more than 6 feet apart, minimum two per wall, and all are to be surge protected type; provide four duplex surge protected outlets at 42 inches AFF in communication closet. Other changes in the desired arrangement will be shown on the shop drawing, also.

Provide approximately, 1-foot wide, perforated aluminum soffits on all four sides and a continuous ridge vent.

All walls are to be vinyl covered sheetrock (all exterior and all interior walls to be fully insulated).

Floors to be double 3/4-inch CDX plywood minimum with vinyl tile floor covering throughout. Color coordinated vinyl base-cove throughout.

Provide eighteen 48-inch by 30-inch minimum sliding, lockable, double pane insulated windows with insect screens and metal mini-blinds.

Provide 4-foot fluorescent lighting fixtures with diffuser covers to provide 100-foot candles of illumination for each and every area; Provide 18-inch fluorescent lighting fixture in bathrooms.

The complete restrooms are to include:

a. An elongated ceramic commode.
b. Ceramic urinal (for one restroom only).
c. Ceramic sink.
d. Single handle brass/chrome faucet (Delta minimum).
e. Vinyl coated wire shelf for supplies 12-inch depth by 24-inch width, minimum.
f. Bobrick No. B-398 stainless steel medicine cabinet with mirror doors.
g. Bobrick No. B-35903 stainless steel paper towel dispenser.
h. Bobrick No. B-697 stainless steel toilet paper holder.
i. 40-gallon hot water heater (to serve both restrooms).
j. Bobrick No. B-147 stainless steel liquid soap dispenser.

Exterior doors to be insulated heavy-duty steel with pneumatic/hydraulic closures and Best lock sets and double cylinder deadbolts. Keyed locksets on all interior doors except restrooms to be privacy type, all to be Kwikset, or equal.

Chrome coat hook on the back of all interior doors.

Interior doors to be pre-hung solid core wood doors with wood trim, all painted gloss white.

Sound attenuation/insulation in all interior walls is required.

Janitorial equipment closet with door.

Communication equipment closet with door to have painted plywood walls. Up to 24 J-boxes with conduit stubbed to under trailer for use in communication installation including up to 2 wall mounted phone boxes. Stainless steel switch-plate and outlet covers. Master circuit surge protector. Lights and receptacles to be on separate circuits; provide 10 dedicated circuits for computers, copiers, etc. Emergency lights and lighted exit signs.

Three 10-pound fire extinguishers mounted at each exit and at break area.

High-pressure sodium photocell controlled light at each entrance, and four exterior flood lights to illuminate parking area.

Freeze protection system for water piping, black asphalt architectural shingles, 20-year

warranty roof, color-coordinated plastic or PVC skirting with access door, porch with landing, steps and full aluminum canopy at each exterior door.

Provide 4” black rain gutter system along entire length of both sides of the trailer along with downspouts, and splash blocks.

HVAC system to include:

k. Dual one-ton minimum heat pump units; two-ton minimum total.
l. No "end pack" units. A factory applied marine coating of all metal parts on the exterior heat pump unit excepting only the compressor fins is required (no field application of this coating is permitted); auxiliary, in duct heat strips as required; piped condensate drains to eliminate surface evaporation including dry well if needed; single programmable thermostat to control both units simultaneously; easily accessible filter locations; individual returns and supplies for all rooms or spaces including hallways.
m. Locate units at center of each side of building for optimum and equal air distribution.
n. All HVAC duct is to be insulated and run on the underside of the trailer with vents in each area in the floor strategically located on interior walls, behind doors.
o. HEPA air filtration system including manufacturer's recommended maintenance.

Computer Systems: Local Area Network. Furnish and install CAT-5e cable, terminations, and connectors to connect the Ethernet 10/100 cards on the computer systems, the printer Ethernet card and copier as a local area network. Cable to be professionally and neatly installed inside the walls or under the floor. Furnish the services of a qualified field technician to set up the Windows XP software as a local area network to function as instructed by the Engineer.

Furnish and install two (2) Dell Dimension 9200 with Intel Pentium D Processor 915 (4MB L2 Cache, 2.8 GHz, 800 FSD) or latest equivalent model. Personal Computer Systems, each equipped as follows:

i. 2GB Display Adapter and internal 500GB hard drive storage.
ii. Internal Dual Drive 16X CD/DVD Burner (DVD+RW)
iii. Optical USB support mouse.
iv. 20” Wide Screen Flat Panel display
v. Battery Back-up UPS systems by APC Model Back-UPS ES 725 Broadband (BE725BB).
vi. Dell USB Keyboard
vii. Microsoft Office Professional 2010, Small Business+ Access database
viii. 3 Year On-Site Business Standard Plan
ix. Adobe Acrobat Reader 10.0
x. Integrated Intel PRO 10/100 Ethernet Network Card
xi. HP Color Laser Jet 3600n printer (equivalent latest model)

Furnish two (2) Laptop computers equipped as follows:

xii. Operating System: Windows, latest version
xiii. Memory: 2GB DDR2 SDRAM at 667 MHZ, 2 DIMM each
xiv. Hard Drive: 250GB Hard Drive
xv. Combo/DVD+RW Drives: 8X CD/DVD Burner/DVD (Blue Ray) Combo Drive
xvi. Network Card and Modem: Integrated 10/100/1000 Network Card and Modem.
xvii. External Keyboard & Mouse: Wireless Optical mouse & Keyboard (Bluetooth)
xviii. Port Replicator: D/Dock, Expansion Station.
xix. Additional Battery: 9-cell Lithium Ion Additional Battery (80 WHr).
xx. Multimedia Cable Kit
xxi. Notebook carrying case (leather)
xxii. Provide maintenance service agreements for all hardware for duration of contract.

Computer Software, Latest Versions for each computer system.(Note: This software shall be supplied in addition to the software specified in Specification 01350- Project Document Tracking and Control System);

xxiii. Microsoft Windows, latest version
xxiv. Microsoft Office, latest version
xxv. Adobe Professional, latest version
xxvi. Bluebeam Revu, latest verion

Wall jacks are to be located as designated by the Engineer.

Provide the following furnishings, fixtures, and equipment, as modified and approved by the Engineer, as follows:

p. Seven (7) - 60 x 30-inch desks.
q. Nine (9) - 36 x 12 x 72-inch bookcases.
r. One (1) - 46 x 144-inch conference table.
s. Seven (7) Herman Miller Aeron ® loaded chairs w/Titanium base. (color-carbon).
t. Fourteen (14) - swivel/tilt conference arm chairs approximately twenty-two (22) inches wide.
u. Six (6) - side chairs.
v. Six (6) Fireking 22125, black, 4-drawer, legal locking fireproof file cabinets.
w. Two (2) - metal storage cabinet, 36 x 78 x 18-inch w/ lock.
x. One (1) - drafting table, 37.5 x 72-inch top.
y. Two (2) - drafting stool.
z. One (1) - 1.2 cubic, 900 watt microwave.

aa. One (1) - minimum 18 cubic feet refrigerator/freezer with ice maker.
bb. Eight (8) - marker board, 4 x 6-feet.
cc. One (1) - mobile plan rack w/ 8 clamps.
dd. Two (2) - drafting fluorescent light with bulbs.
ee. One (1) - water cooler with bottled water, with hot and cold potable water.
ff. One (1) double pot coffee machine with water supply connection.
gg. One (1) boot scraper with dual brushes for each exterior door.
hh. Six (6) Tenex static control chair mats, 46-inch by 60-inch with 33-inch by 10-inch lip, standard weight.
ii. Six (6) tall black plastic trash receptacles (Rubbermaid).

Provide the following Video/Photo Electronics:

jj. Two (2) Canon Power Shot SD1000 Digital Elph Camera or equivalent current model with 4 GB SD Memory Card, soft carry case, and spare battery.

Provide one (1) plain paper copier machine, Konika Minolta, Model DI 5510 or equivalent current model (Owners choice) with automatic document feeder, multisheet and single sheet feeder, 5-1/2 by 8-1/2 to 11 by 17; zoom reduction/enlargement from 64 percent to 156 percent in 1 percent increments; 3 paper supply trays with 250 sheets each (8-1/2 by 11, 8-1/2 by 14, 11 by 17); and with a office finisher with multi-position stapling and optional hole punching. The Contractor shall provide a three-year maintenance service contract and copy paper, toner/ink cartridges, etc., for this machine during the Contract period plus 6 months. Furnish two spare toner/ink cartridges for each machine at all times.

The Contractor shall be responsible for all office setup costs including electrical, water, sewer, and telephone installation costs. The Contractor is also responsible for all service and maintenance including cleaning, light bulbs, and HVAC filters, etc. for the City field office.

The Contractor shall furnish the services of a professional computer system installer to install, connect, and test the various computers, printers, communication equipment, and other peripherals specified in this Section. The various cable types, lengths, adapters, and other connectors are not listed below and will have to be furnished to conform to the Project office and equipment layout and to complete the installation as a satisfactorily functioning system. In addition, maximum effort shall be made to terminate the various cables in wall mounted outlets with appropriate connectors to reduce cable clutter and achieve an orderly appearance for the installation. The wall outlets are also not listed below. The same professional firm shall provide a full on-site maintenance agreement covering all replacement parts and labor. The Contractor shall provide operational support of the computer network for the duration of the construction Contract.

The Contractor shall provide free and clear access for the occupants and visitors for the

duration of the Project.

The Contractor shall protect all utility lines leading to and from the Project office, including all water, sewer, gas, telephone, and other communication lines.

1-6. TELEPHONE SERVICES.

1-6.01. General.

A telephone system to be installed and maintained for the duration of the project.

Make all necessary arrangements for outside telephone service to Contractor's office, Engineer's Field Office, and the First Aid Stations. The connection to Engineer's Facilities shall be consistent with the specified hardware requirements for such facilities. Schematic drawings, showing the complete telephone system to be installed, shall be provided for review by the Engineer before installation of the service. All portions of the communication system shall be maintained in good working condition.

All expenditures for installation costs of hardware, lines, line extensions, service changes, and recurring service charges for telephone service shall be paid by the Contractor.

The Contractor shall provide the Engineer's Field Office with two (2) dedicated lines, with paging, voice mail, conference calling, speaker phone, redial and speed dialing, call and message waiting signals, volume control, outgoing call restriction, night service, and flexible function keys.

One phone sets will be provided in each office, and in the conference room.

The Contractor shall furnish two (2) additional dedicated telephone lines to the Engineer's Project Office. At each office, one (1) line will be used for a dedicated facsimile machine. The second line at each office will be used for dedicated computer communications.

The Contractor shall furnish one (1) cable modem, ADSL, DSL or ISDN line to the Engineer's Project Office. These lines will be used to access the server for the Primavera Expedition software maintained in the Engineer's Project Office.

1-7. PARKING FACILITIES.

1-7.01. The Contractor shall provide ample parking, either graveled or paved, adjacent to Engineer's Field Office(s), without necessitating jockeying of cars, for a minimum of ten (10) cars at Engineer's Project Office.

1-7.02. The parking surfaces shall be promptly and adequately maintained by the Contractor for the duration of the Contract.

1-8. SECURITY AND MAINTENANCE.

1-8.01. The Contractor shall provide periodic indoor and outdoor maintenance and weekly cleaning for the Engineer's Field Office, furnishings, equipment, and services as specified herein above. This shall include maintenance of the grounds, including picking up trash and mowing grass.

1-8.02. During other than normal daytime office working hours, provide a totally separate electronic security system monitored by a security agency for the Engineer's facilities. All offices shall be equipped with exterior security flood lights automatically activated by darkness and in sufficient number and placement to provide adequate lighting of the office and the parking areas.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3-1. PREPARATION. The Contractor shall fill and grade sites for temporary structures to provide surface drainage

3-2. INSTALLATION.

3-2.01. The Contractor shall construct temporary field offices, first aid stations, and storage facilities on proper foundations and provide connections for utility all services.

3-2.02. The Contractor shall locate construction office facilities at locations within the Project approved by the Engineer.

3-2.03. The Contractor shall determine the need for temporary utility services, including utility services for Engineer's facilities and first aid stations, and make all arrangements with utility companies and governmental agencies to secure such services. Such services shall be provided at no additional cost to the City. Temporary utility services shall be furnished, installed, connected, and maintained by Contractor in a workmanlike manner, satisfactory to the Engineer, and shall be removed in like manner prior to final acceptance.

3-2.04. The Contractor shall provide an outside standpipe equipped with a non-freeze hose bib at Engineer's Project Office. The hosebib is to be sized for a standard ½" garden hose connection.

3-3. MAINTENANCE AND CLEANING.

3-3.01. For the duration of the Project, the Contractor shall repair and clean the office, parking area, and access route and provide complete professional janitorial services,

including toilet paper and paper towels, liquid soap, air fresheners in the Engineer's Field Office. The Contractor or the janitorial service is to provide floor mats at exterior entrances (inside and outside of door).

3-3.02. Cleaning shall be done on a weekly basis, to the satisfaction of the Engineer, during other than normal daytime office working hours. These services shall include sweeping, vacuuming, dusting, emptying of trash, cleaning of wash basins, bathroom and shower facilities, mopping and monthly waxing of all vinyl floors.

3-3.03. Contractor shall also provide for monthly exterminating services of the offices.

3-4. REMOVAL.

3-4.01. The Contractor shall remove temporary field offices, contents and services at a time when no longer needed. The office contents shall be packed, moved, and unpacked by the Contractor to a location designated by the City.

3-4.02. The Contractor shall remove foundations and debris; grade site to required elevations; clean and restore areas to Engineer's satisfaction.

End of Section

SECTION 01540

SECURITY AND SAFETY

PART 1 - GENERAL

1-1. SECURITY PROGRAM

1-1.01. The Contractor shall protect the Work, including all field office trailers and their contents from theft, vandalism, and unauthorized entry.

1-1.02. The Contractor shall initiate a site security program at the time of mobilization onto the worksite, which provides adequate security for site stored and installed material.

1-1.03. The Contractor shall maintain the security program throughout the Contract duration.

1-1.04. The Contractor and subcontractors are wholly responsible for the security of their storage compound and lay down areas and for all their plant, material, equipment and tools at all times.

1-1.05. The Contractor shall provide the Engineer with a list of 24 hour emergency phone numbers including chain of command.

1-2. ENTRY CONTROL

1-2.01. The Contractor shall restrict entry of unauthorized personnel and vehicles onto the Project site.

1-2.02. The Contractor shall allow entry only to authorized persons with proper identification.

1-2.03. The Contractor shall maintain an Employee Log and Visitor Log and make the log available to the City upon request. This log shall be submitted to the Engineer bi-weekly or as necessary.

1-2.04. The Contractor shall require all visitors to sign the Visitor Acknowledgment of the Program Site Rules/Visitor Log, which includes a release form. Copies of these forms shall be submitted to the Engineer bi-weekly and maintained in the Contractor's security files on-site.

1-2.05. The Contractor shall require all employees to sign the Employee Acknowledgment of Project Site Rules Log included at the end of this Section. All employees, subcontractor employees and lower tier contractor employees will receive a new employee orientation.

Signing the Employee Log by the employee is certifying that the orientation training has been received.

1-2.06. The Engineer has the right to refuse access to the site or request that a person or vehicle be removed from the site if found violating any of the Project safety, security conduct rules.

1-3. BARRICADES, LIGHTS AND SIGNALS

1-3.01. The Contractor shall furnish and erect such barricades, fences, lights and danger signals and shall provide such other precautionary measures for the protection of persons or property and of the work as necessary. Barricades shall be painted in a color that will be visible at night. From sunset to sunrise, the Contractor shall furnish and maintain at least one light at each barricade and sufficient numbers of barricades shall be erected to keep vehicles from being driven on or into any work under construction.

1-3.02. The Contractor will be held responsible for all damage to the work and any resulting injuries due to failure of barricades, signs and lights and whenever evidence is found of such damage, the Contractor shall immediately remove the damaged portion and replace it at Contractor's cost and expense. The Contractor's responsibility for the maintenance of barricades, signs and lights shall not cease until the Project has been accepted by the City.

1-4. RESTRICTIONS

1-4.01. The Contractor shall not allow cameras on site or photographs taken except with approval of the City or the Engineer.

1-5. CONTRACTOR SAFETY/HEALTH AND SECURITY PLAN

1-5.01. Prior to the performance of any work the Contractor will prepare a contract specific Safety/Health and Security Plan signed by an officer of the Contractor's organization. Adequacy is the responsibility of the Contractor.

1-5.02. The Engineer will not review the Contractor's safety plan for the adequacy of the plan. The plan shall:

Identify the person(s) responsible for implementation and enforcement of Safety/Health and Security rules and regulations for this Project.

Generally address safe work procedures for the activities within the Contractor's scope of work.

Include a new employee orientation program, which addresses job and site specific rules, regulations and hazards.

Include the Contractor's Drug Free Work Place Policy including substance abuse prevention and testing program.

Include provisions to protect all of the Contractor's employees, other persons and organizations who may be affected by the work from injury, damage or loss.

Comply with current Fed/OSHA, Safety/Health and Security Plan, facility safety program (when applicable), and locally accepted safety codes, regulations and practices.

Include a site specific emergency action and evacuation plan.

Include Hazard Communication/Right To Know Program.

Include security procedures for the Contractor's work, tools, and equipment.

Include the capability of providing the Engineer with documentation to show compliance with their plan, plus accidents and investigation reports.

Address any other contract specific requirement, including the,Unique Requirements of these specifications.

1-5.03. Provide a Job Safety Analysis (JSA) for the scope of work, prior to the start of work.

1-5.04. Review of the Contractor's Safety Plan by the Engineer shall not impose any duty or responsibility upon the Engineer for the Contractor's performance of the work in a safe manner.

1-5.05. The Contractor shall be fully responsible for the safety and health of its employees, its subcontractors and lower tier contractors during performance of its work.

1-5.06. The Contractor shall provide the Engineer with all safety reports, training records, competent person list, and accident reports prepared in compliance with Fed/OSHA and the Project Safety/Health and Security Plan.

1-6. PROJECT SAFETY COORDINATOR

1-6.01. The Contractor shall be responsible for the safety of the Contractor’s and Engineer’s employees, the City’s personnel and all other personnel at the site of the Work. The Contractor shall identify a Project Safety Coordinator, as required under GC-18, Paragraph F., on the job with an appropriate office on the job site to maintain and keep available safety records and up-to-date copies of all pertinent safety rules and regulations.

1-6.02. The Project Safety Coordinator shall: Ensure compliance with all applicable health and safety requirements of all governing legislation.

Schedule and conduct safety meetings and safety training programs as required by law for all personnel engaged in the work.

Post all appropriate notices regarding safety and health regulations at locations that afford maximum exposure to all personnel at the job site.

Post the name, addresses, and hours of the nearest medical doctor; names and addresses of nearby clinics and hospitals; and the telephone numbers of the fire and police departments.

Post appropriate instructions and warning signs with regard to all hazardous areas or conditions.

Have proper safety and rescue equipment adequately maintained and readily available for any contingency. This equipment shall include such applicable items as: proper fire extinguishers, first aid kits, safety ropes and harnesses, stretcher, life savers, oxygen breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, explosion meters, and any other equipment mandated by law.

Make inspections at least once daily in accordance with an inspection checklist report form to ensure that all machines, tools and equipment are in safe operating condition; that all work methods are not dangerous; and that all work methods are free of hazards.

Submit to the Engineer upon request copies of all inspection checklist report forms, safety records and all safety inspection reports and certifications from regulating agencies and insurance companies.

Notify Engineer of a serious accident immediately, followed by a detailed written report within twenty-four (24) hours. “Serious accident” is defined as that requiring an absence of work of more than 2 days and/or hospitalization.

Notify the Engineer immediately in the event of a fatal accident.

Notify Engineer of any accident claim against the Contractor or any sub-contractor immediately, followed up by a detailed written report on the claim and its resolution.

Review safety aspects of the Contractor’s submittals as applicable.

VISITOR ACKNOWLEDGMENT OF THE PROJECT SITE RULES

By signing this Visitor's Log, I acknowledge that I understand and agree to abide by the project rules outlined below.
In consideration of my receipt of a visitor's pass as issued by the Engineer directly or indirectly for the City of Atlanta, I waive on behalf of myself, my heirs, employer, legal representatives and assigns and hereby release and discharge the City, Engineer, Designer, and their subcontractors and consultants and each of their directors, officers, employees, representatives and agents from any and all claims, actions, causes of action or any charge of any kind whatsoever which may arise or could arise in the future as a result of my being present at the facility including injury, death or property damage whether or not caused by the fault or negligence of any of the parties released hereunder.

I further acknowledge that I have been briefed on specific hazards, hazardous substances that are on site and the site emergency action procedure.

PROHIBITED ACTIVITIES

- Unauthorized removal or theft of CITY's property
- Violation of safety or security rules or procedures
- Possession of firearms or lethal weapons on jobsite
- Acts of sabotage
- Destruction or defacing CITY's property
- Failure to use sanitary facilities
- Failure to report accidents or job related injuries
- Being under the apparent influence of drugs, alcohol or other intoxicants or in possession of drugs, alcohol or other intoxicants on the property
- Wearing shorts or tennis shoes on the jobsite
- Failure to wear a hardhat/safety glasses.
- Gambling at any time on the project
- Fighting, threatening behavior, or engaging in horseplay on the project
- Smoking in unauthorized areas on the project
- Open fire cooking or making unauthorized fires on project property
- Selling items or raffles without authorization
- Use of unauthorized cameras on the project
- Use of radio or television in the construction area
- Failure to park personal vehicle in authorized parking area
- Failure to wear designated identification [Site Specific]
- Failure to use designated gates

I have read, understand and agree to abide by the PROJECT SITE RULES. Furthermore, I understand failure to abide by these rules is grounds for being denied access to the project site. I have received a personal copy for my use and reference.

VISITOR LOG

THE SIGNING OF THIS LOG ACKNOWLEDGES I HAVE READ AND UNDERSTAND AND AGREE TO ABIDE BE THE PROJECT RULES OUTLINE ABOVE. THIS IS NOT A VEHICLE ACCESS PERMIT.

VISITOR'S NAME PRINT	SIGNATURE	COMPANY VISITED	DATE	IN	OUT

EMPLOYEE ACKNOWLEDGMENT OF THE PROJECT SITE RULES

By Signing this Employee Log, I acknowledge that I understand and agree to abide by the project rules outlined below.

PROHIBITED ACTIVITIES

- Unauthorized removal or theft of CITY's property
- Violation of safety or security rules or procedures
- Possession of firearms or lethal weapons on jobsite
- Acts of sabotage
- Destruction or defacing CITY's property
- Failure to use sanitary facilities
- Failure to report accidents or job related injuries
- Under the apparent influence of drugs, alcohol or other intoxicants or in possession of drugs, alcohol or other intoxicants on the property
- Wearing shorts or tennis shoes on the jobsite
- Failure to wear a hardhat
- Gambling at any time on the project
- Fighting, threatening behavior, or engaging in horseplay on the project
- Smoking in unauthorized areas on the project
- Open fire cooking or making unauthorized fires on project property
- Selling items or raffles without authorization
- Use of unauthorized cameras on the project
- Use of radio or television in the construction area
- Failure to park personal vehicle in authorized parking area
- Failure to wear designated identification [Site Specific]
- Failure to use designated gates

I have read, understand and agree to abide by the PROJECT SITE RULES. Furthermore, I understand failure to abide by these rules is grounds for being denied access to the project site. I have received a personal copy for my use and reference.

EMPLOYEE LOG

BY SIGNING THIS LOG ACKNOWLEDGMENT I HAVE READ AND UNDERSTAND AND AGREE TO ABIDE BY THE PROJECT RULES OUTLINED ABOVE AND ALL STATE, FEDERAL, LOCAL OR ANY OTHER CONTRACT OBLIGATIONS THAT MAY APPLY. I FURTHER ACKNOWLEDGE THAT I HAVE BEEN ORIENTATED AS TO THE SITE SPECIFIC HAZARDS, ANY HAZARDOUS SUBSTANCES I MAY BE EXPOSED TO WHILE ON THE SITE AND THE SITE/COMPANY EMERGENCY ACTION PROCEDURES, BY A REPRESENTATIVE OF THE COMPANY.

EMPLOYEES (PRINT)	SIGNATURE	COMPANY NAME	DATE
Signature of Company Representative		Date Signed	

End of Section

SECTION 01550

TRAFFIC REGULATION

PART 1 - GENERAL

1-1. SCOPE

The work specified in this section includes the provision of products, permits, services, procedures and personnel by the Contractor to effect traffic control during the Work.

1-2. TRAFFIC CONTROL MANAGER REQUIREMENTS

1-2.01. The Contractor shall designate a qualified individual as the Traffic Control Manager (TCM) who shall be responsible for selecting, installing and maintaining all traffic control devices in accordance with the Plans and Specifications and the Manual of Uniform Traffic Control Devices (MUTCD). A written resume documenting the experience and credentials of the TCM shall be submitted and accepted by the Engineer prior to beginning any work that involves traffic control. The TCM shall be available on a twenty-four (24) hour basis to perform his duties. If the work requires traffic control activities to be performed during the daylight and nighttime hours it may be necessary for the Contractor to designate an alternate TCM. An alternate TCM must meet the same requirements and qualifications as the primary TCM and be accepted by the Engineer prior to beginning any traffic control duties. The Traffic Control Manager's traffic control responsibilities shall have priority over all other assigned duties.

1-2.02. As the representative of the Contractor, the TCM shall have full authority to act on behalf of the Contractor in administering the Traffic Control Plan. The TCM shall have appropriate training in safe traffic control practices in accordance with Part VI of the MUTCD. In addition to the TCM all other individuals making decisions regarding traffic control shall meet the training requirements of Part VI of the MUTCD. The TCMs shall supervise the initial installation of traffic control devices. The Engineer prior to the beginning of construction will review the initial installation. Modifications to traffic control devices as required by sequence of operations or staged construction shall be reviewed by the TCMs.

PART 2 - PRODUCTS

2-1. SIGNS, SIGNALS, AND DEVICES

2-1.01. The Contractor shall provide post-mounted and wall-mounted traffic control and informational signs as specified and required by local jurisdictions.

2-1.02. The Contractor shall provide automatic traffic control signals as approved by local jurisdictions.

2-1.03. The Contractor shall provide traffic cones and drums, and flashing lights as approved by local jurisdictions.

2-1.04. The Contractor shall provide flagmen equipment as required by local jurisdictions.

PART 3 - EXECUTION

3-1. PERMITS

3-1.01. The Contractor shall obtain permits from authorities having jurisdiction over road closures before closing any road. The Contractor shall use forms provided by authorities having jurisdiction (City of Atlanta Division of Traffic and Transportation, GDOT, etc).

3-1.02. The Contractor shall either fax or hand carry permit applications to the City of Atlanta Division of Traffic and Transportation. Permit applications shall indicate the time (in days); length (in feet); the number of lanes; and the purpose of the closure.

3-1.03. All permits are approved for operations during off-peak hours 9:00 a.m. to 4:00 p.m. unless special approval is received.

3-1.04. Operations between the hours of 6:00 p.m. and 10:00 p.m. and Saturdays and Sundays must be approved by the City

3-1.05. Full street closures permits require ninety-six (96) hours advance notice prior to road closure. The following additional information is required prior to approval:

The recommended detour route with signage and Traffic Management Plan as per the Manual of Uniform Traffic Control Devices (MUTCD).

A copy of the resident and/or business notification letters about the closure. The residents/businesses located between the detour route must be notified about the closure at least five (5) business days prior to the proposed closure.

3-1.06. The City of Atlanta Division of Traffic and Transportation will return full road closure permit applications to the Contractor with a cover letter to the Fire Chief, Chief of Police, Grady Memorial Hospital, MARTA, and the Atlanta Board of Education. The Contractor shall have received the permit application and cover letter at least seventy-two (72) hours before commencing road closure activities.

3-1.07. Lane closures shall require a minimum of forty-eight (48) hour notice prior to closure. The Contractor shall continuously maintain the safety of the traveling public during lane closures in accordance with the requirements of the MUTCD and as stipulated by public officers. Lane closure permits are issued between 8:30 a.m. and 1:00 p.m. Mondays through Fridays.

3-1.08. The City of Atlanta Division of Traffic and Transportation will return the lane closure applications to the Contractor with a cover letter with copies to the Fire Chief, Chief of Police, Grady Memorial Hospital, MARTA, and the Atlanta Board of Education. The Contractor shall have received the permit application and cover letter at least seventy-two (72) hours before commencing lane closure activities.

3-2. PREPARATION OF TRAFFIC CONTROL PLANS

3-2.01. The Traffic Control Plan drawings included with the Contract Documents shall only be considered as a guide and are not intended to contain all the traffic regulation details that may be required by the specifications, permitting agencies and the MUTCD. The Contractor shall develop detailed staging and traffic control plans for performing specific areas of the Work including but not limited to all requirements for certified flagmen, additional traffic control devices, traffic shifts, detours, paces, lane closures or other activities that disrupt traffic flow. The Contractor shall submit these plans in accordance with the Specifications to receive final approvals from permitting agencies and provide any and all required traffic control devices as required by both the permitting agencies and these specifications at no additional cost to the City.

3-3. CONSTRUCTION PARKING CONTROL

3-3.01. The Contractor shall control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and City's operations.

3-3.02. The Contractor shall monitor parking of construction personnel's vehicles in existing facilities and maintain vehicular access to and through parking areas.

The Contractor shall prevent parking on or adjacent to access roads or in nondesignated areas.

3-4. MAINTENANCE OF TRAFFIC

3-4.01. Whenever and wherever, in the Engineer's opinion, traffic is sufficiently congested or public safety is endangered, the Contractor shall furnish uniformed officers to direct traffic and to keep traffic off the highway area affected by construction operations.

3-4.02. When the Contract requires the maintenance of vehicular traffic on an existing road, street, or highway during the Contractor's performance of Work that is otherwise provided for in the Plans and these Specifications, the Contractor shall keep such road, street, or highway open to all traffic and shall provide such maintenance as may be required to safely accommodate traffic. The Contractor shall furnish, erect and maintain barricades, warning signs, flagmen, and other traffic control devices in conformity with the requirements of the Georgia Department of Transportation and other Local Jurisdictions. The Contractor shall also construct and maintain in a safe condition any temporary connections necessary to ingress to and egress from abutting property or intersecting roads, streets, or highways. The Contractor shall maintain traffic in accordance with any traffic control plans furnished with and made a part of the Plan assembly.

3-4.03. The Contractor shall make his own estimate of all labor, materials, equipment, and incidentals necessary for providing the maintenance of traffic as specified in this section.

3-4.04. Unless specified in the Plans or these Specifications and subject to the approval of the City, the cost of maintaining traffic specified in this section shall be considered incidental to the Work and no separate measurement or payment will be made.

3-5. UNIFORMED POLICE OFFICER FOR TRAFFIC CONTROL

3-5.01. The Contractor shall provide uniformed police officers to regulate traffic when construction operations encroach on public traffic lanes, as approved by the Engineer.

3-5.02. Officers will be currently employed by a local jurisdiction, be in full uniform and have full arrest power while working.

3-5.03. Officers will be employed and paid by the Contractor.

3-5.04. It is the Officers' responsibility to assist in the direction of traffic within the construction site.

3-6. FLAGMEN

3-6.01. The Contractor shall provide trained and equipped flagmen to regulate traffic when construction operations or traffic encroach on public traffic lanes.

3-7. FLASHING LIGHTS

3-7.01. The Contractor shall use flashing lights during hours of low visibility to delineate traffic lanes and to guide traffic.

3-8. HAUL ROUTES

3-8.01. The Contractor shall consult with authorities and establish public thoroughfares to be used for haul routes and site access.

3-8.02. The Contractor shall confine construction traffic to designated haul routes.

3-8.03. The Contractor shall provide traffic control at critical areas of haul routes to regulate traffic and minimize interference with public traffic.

3-9. ROAD CLOSURES ON CITY ROADS

3-9.01. No street, road, or highway shall be closed without the permission of the owner of any street, road, or highway and the fire department having jurisdiction. Prior to closing a street, road, or highway, signs shall be posted for a minimum of seven (7) days prior to actual closing, forewarning of the imminent closing. The City shall determine the information to be placed upon the signs by the Contractor. Where traffic is diverted from the Work, the Contractor shall provide all materials and perform all work for the construction and maintenance of all required temporary roadways, structures, barricades, signs, and signalization.

3-9.02. To obtain approval to close a road or street maintained by the City, the Contractor must proceed as follows:

The Contractor must obtain approval of his traffic plan from the Engineer unless a traffic plan approved by the Engineer is included in the Plans. The traffic plan must be in accordance with the requirements of the Georgia Department of Transportation and the City of Atlanta.

The Contractor must obtain a utility permit.

The Contractor must apply in writing to the City and obtain a permit to close the road on a specific date. Routine permit approval by the City requires from one (1) to two (2) weeks depending on when the application is received.

The Contractor must obtain a permit from the City before posting closure signs. Signs must be posted for seven (7) days prior to the first day of closure. Signs must be acceptable to the Engineer.

Emergency road closures will be handled by the Engineer.

3-10. PROCEDURES FOR TRAFFIC DETOUR ROUTE PLAN

3-10.01. The Contractor shall provide a sketch map showing his traffic detour route plan to the Engineer. The sketch map need not be drawn to scale but should resemble, as closely as possible, the actual location. The sketch map shall be drawn in a manner so as to provide emergency agencies a better

understanding of the detour for quick response. The sketch map shall include directional arrows showing the flow of traffic.

3-10.02. “Road Closed Ahead” signs shall be erected before the start point of the detour indicating the name of the street closed.

3-10.03. Detour signs with appropriate directional arrows shall be erected at every intersection along the detour route until the end of the detour, when the traffic is back to the original street.

3-10.04. The Contractor shall erect an “End Detour” sign at the end of the detour.

3-10.05. Each detour and “End Detour” sign shall be accompanied by an accessory plate indicating the name of the street being detoured.

3-10.06. The Contractor shall apply appropriate traffic control measures in accordance with the requirements of the MUTCD and the City of Atlanta codes.

3-11. BARRICADES AND WARNING SIGNS

3-11.01. The Contractor shall furnish, erect, and maintain all barricades and warning signs for hazards necessary to protect the public and the Work. When used during periods of darkness, such barricades, warning signs and hazard markings shall be suitably illuminated or reflectorized.

3.11.02. For vehicular and pedestrian traffic, the Contractor shall furnish, erect, and maintain barricades, warning signs, lights, and other traffic control devices in conformity with the requirements of the Georgia Department of Transportation and the City of Atlanta.

3.11.03. The Contractor shall furnish and erect all barricades and warning signs for hazards prior to commencing Work which requires such erection and shall maintain the barricades and warning signs for hazards until their dismantling is directed by the Engineer.

3-12. REMOVAL

3-12.01. The Contractor shall remove equipment and devices when no longer required and repair damage caused by installation.

End of Section

SECTION 01600

GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

PART 1 - GENERAL

1-1. DESCRIPTION.
All installed materials and equipment are to be the latest version of the manufacturers product line and not be outdated by newer versions at the time of purchasing. Materials and equipment, which show any signs of extended storage such as corrosion, scratches and dents, will not be accepted for installation in this project.

All equipment used for performing the Work shall conform to the latest version of all applicable safety standards including but not limited to OSHA requirements. Contractor shall not exceed or ignore any requirements or recommendations of the equipment manufacturer. Equipment not meeting requirements of this Section will be barred from use on the project.

All installed material and equipment shall meet or exceed the latest applicable code requirements including but not limited to, Underwriters Laboratory, Standard Building Code and OSHA, as well as requirements of these Specifications. Where there is conflict with requirements of the Contract Documents and code requirements, comply with the more stringent requirements with no additional compensation to the Contractor.

PART 2 - PRODUCTS

2-1. ANCHOR BOLTS.
All anchor bolts to be ANSI type 316 stainless steel unless otherwise specified or indicated, and must conform to requirements of this Section and the material articles in the appropriate Sections they are used.

All anchor bolts are to be supplied by the manufacturer or fabricator of the specific material or equipment to be installed.

2-1.01. Design criteria for anchor bolts. When the size, length or load carrying capacity of an anchor bolt, expansion anchor, or concrete insert is not shown on the Drawings, provide the size, length and capacity required to carry the design load times a minimum safety factor of four.

Determine design loads as follows:

a. For equipment anchors, use the design load recommended by the manufacturer and approved by the Engineer.
b. For pipe hangers and supports, use one half the total weight of pipe,

fittings, valves, accessories and water contained in pipe, between the hanger or support in question and adjacent hangers and supports on both sides.

c. Allowances for vibration are included in the safety factor specified above.
d. Anchors shall develop ultimate shear and pull-out loads of not less than the following values in concrete:

Bolt Diameter (Inches)	Min. Shear (Pounds)	Min. Pull-Out Load (Pounds)
½	4,500	6,300
⅝	6,900	7,700
¾	10,500	9,900

3. Embedment depth to be 6 inches for epoxy anchors and 4 inches for steel expansion anchors, unless noted otherwise on the drawings.

2-1.02. Anchor Type and Manufacturer. Where epoxy anchors are noted on the drawings, provide ANSI type 316 stainless steel threaded rod with Speed Bond #1 epoxy injection as manufactured by Prime Resins, Inc. or equal.

For all other applications, provide ANSI type 316 steel expansion anchors from one of the following manufacturers.

a. Hilti, Incorporated.
b. Ramset, Incorporated.
c. Or equal.

Install anchors per manufacturer's recommendations and this Section.

d. Drilled anchorage holes are to be blown out with compressed air before installing anchor.

2-2. CONNECTION BOLTS.

Materials shall be as specified in other Sections of the Specifications, or as shown on the Drawings. Where materials are not specified or shown on the Drawings, they shall be of ANSI Type 316 stainless steel, with ANSI Type 316 stainless steel nuts and washers.

Unless otherwise specified, stud, tap and machine bolts and nuts shall be ANSI Type 316 stainless steel and shall conform to the requirements of ASTM Standard Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307-80. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to AN Standard B1.1-1974 for Unified Inch Screw Threads (UN and UNR Thread Form).

2-3. CONCRETE INSERTS. Concrete inserts for hangers shall be designed to support safely, in the concrete that is used, the maximum load that can be imposed by the hangers used in the inserts. Inserts for hangers shall be of a type, which will permit adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. All inserts shall be galvanized, then epoxy phenolic primed and top coated with PVC, using thermal bond process.

2-4. SLEEVES.
Unless otherwise indicated on the Drawings or specified, openings for the passage of pipes through floors and walls shall be formed of sleeves of standard-weight, stainless-steel pipe. The sleeves shall be of ample diameter to pass the pipe and its insulation, if any, and to permit such expansion as may occur. Sleeves shall be of sufficient length to be flush at the walls and the bottom of slabs and to project 4-in. above the finished floor surface. Threaded nipples shall not be used as sleeves.

Sleeves in exterior walls below grade or in walls to have liquids on one or both sides shall be as detailed on the Drawings and specified in other sections.

All sleeves shall be set accurately before the concrete is placed or shall be built in accurately as the masonry is being built.

2-5. ELECTRICAL EQUIPMENT ENCLOSURES. All items of electrical equipment that are furnished with process equipment shall conform to the requirements specified under the appropriate electrical sections of the specifications. Enclosures for electrical equipment such as switches, starters, etc., shall conform to the requirements specified under the appropriate electrical sections of the specifications.

2-6. EQUIPMENT DRIVE GUARDS. All equipment driven by open shafts, belts, chains, or gears shall be provided with acceptable all-metal guards enclosing the drive mechanism. Guards shall be constructed of epoxy paint coated, galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps, which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

2-7. NAMEPLATES.
With the exception of the items mentioned below, each piece of equipment shall be provided with a substantial nameplate of non-corrodible metal, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate.

This requirement shall not apply to standard, manually operated gate, lobe, check and plug valves.
Each process valve shall be provided with a substantial tag of noncorrodible metal

securely fastened in place and inscribed with an identification number in conformance with the tag numbers indicated on the Process and Instrumentation Drawings.

2-8. LUBRICANTS. During testing and prior to acceptance, the Contractor shall furnish all lubricants necessary for the proper lubrication of all equipment furnished under this contract.

2-9. PROTECTION AGAINST ELECTROLYSIS. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

2-10. TRANSPORTATION, HANDLING, STORAGE AND PROTECTION.

2-10.01. Packing and Shipping. Product and materials shall be shipped and handled in ways which will prevent damage.

Equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to the project site. Bearing housing, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

Ship equipment, material, and spare parts in assembled units except where partial disassembly is required by transportation regulations or for protection of components.

Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

Stiffeners shall be used where necessary to maintain shapes and to give rigidity.

Each item or package shall be marked with the number unique to the specification reference covering the item. Spare parts shall be packed in containers bearing labels clearly designating contents and pieces of equipment for which intended.

2-10.02. Acceptance at Site. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Engineer.

Damage shall be corrected to conform to the requirements of the Contract before the assembly is incorporated into the Work.

The Contractor shall bear the costs arising out of dismantling, inspection, repair, and reassembly.

2-10.03. Storage and Protection. During the interval between the delivery to the site and installation, equipment and materials shall be stored in an enclosed space affording protection from weather, dust, and mechanical damage and providing favorable temperature, humidity, and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

2-11. UNIT RESPONSIBILITY. Equipment systems made up of two or more components shall be provided as a unit by the responsible manufacturer. Unless otherwise specified, the Contractor shall obtain each system from the supplier of the driven equipment, which supplier shall provide all components of the system to enhance compatibility, ease of construction, and efficient maintenance. The Contractor shall be responsible to the City for performance of all system in accordance with the provisions of the General Conditions of the Contract Documents.

Where the detailed specifications require the Contractor to furnish a certificate of unit responsibility, such certificate executed by the manufacturer. No other submittal material shall be processed until the Certificate of Unit Responsibility has been received and has been found to be satisfactory. A typical Manufacturer's Certificate of Unit Responsibility form is included in this specification.

2-12. SERVICES OF MANUFACTURER'S REPRESENTATIVE.
Where manufacturers' services are specified, Contractor shall furnish a qualified representative of the manufacturer to provide these services. Where time is necessary in excess of that stated in the Specifications for the manufacturers' service representative to complete the specified services, the additional time required to perform the services shall be considered incidental work for which the Contractor will receive no additional compensation.

After installation of the listed equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the representative shall inspect, operate, test and adjust the equipment. The inspection shall include, but shall not be limited to, the following points as applicable:

1. Soundness (without cracked or otherwise damaged parts).
2. Completeness in all details, as specified.
3. Correctness of setting, alignment, and relative arrangement of various parts.
4. Adequacy and correctness of packing, sealing and lubricants.

The operation, testing and adjustment shall be as required to prove that the equipment is left in proper condition for satisfactory operation under the conditions specified.

On completion of its work, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer Certificate Submittals in accordance with sub-paragraph N of this paragraph and a complete signed report of the result of his inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance.

The report also shall include a certificate that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

After the Engineer has reviewed the reports from the manufacturers' representative, the Contractor shall make arrangements to have the manufacturers' representatives present when the field acceptance tests are made.

Requirements of this paragraph will be in addition to those of appropriate equipment and material Sections.

2-12.01. Definitions. For purposes of furnishing manufacturers' services, refer to spec. section 01664, and the following definitions shall apply:

a. Manufacturer's Representative: Employee of manufacturer who is factory trained and knowledgeable in technical aspects of their products and systems.
b. Construction Period: The time period from the Contractor's purchase order date to the date of certification by the manufacturer that the material or equipment is properly installed and that functional and performance tests, as applicable to the equipment specified, have been successfully demonstrated.
c. Man-Day: One man for 8 hours straight time, exclusive of Saturdays, Sundays, or holidays.

2-12.02. Fulfillment of Specified Minimum Services. Only those manufacturers' services, including trips to the jobsite or training classroom, receiving prior written acceptance or authorization by the Engineer shall act to fulfill the specified services. If manufacturer's representative is found deficient in training or experience by the Engineer, furnish other acceptable representatives after acceptance of resumes and other documentation of proposed representatives.

2-12.09. Proper Installation of Products and Systems. Furnish manufacturers' representatives of products and systems. Representatives shall resolve assembly or installation problems attributable to, or associated with, their products and systems,

whether or not specifically required in the Specifications.

2-12.10. Functional Testing. Where functional (or run) testing is required in the Specifications, furnish manufacturer's representative to assist with the test. This shall include checking for proper rotation, alignment, speed, excessive vibration, and quiet operation. Perform initial equipment and system adjustment and calibrations in the presence and with the assistance of the manufacturer's representative.

Obtain manufacturer's review and acceptance of Contractor's certification of functional testing, where such certification is specified.

2-12.11. Performance Testing. Where performance testing is specified, furnish manufacturer's representative to assist the test as specified for the particular equipment, and to correct malfunction of equipment. Follow specified test procedures.

These services shall continue until:

a. Equipment or systems have been successfully tested for performance.
b. Performance test report has been reviewed and accepted.
c. Equipment or systems have been accepted by Engineer for startup.

Unless otherwise specified, performance testing shall use plant fluid or material that the equipment or system is designed to handle during normal service conditions.

a. Training of City's Personnel

Contractor's Personnel: Designate and provide Contractor's personnel to be responsible for coordinating and expediting training duties. The person(s) shall be present during training coordination meetings with the Engineer and shall be familiar with the Operation and Maintenance (O & M) Manual information specified in the General Conditions of the Contract Documents.

Manufacturer's Representative: Where training of City's personnel is required in the Specifications, furnish manufacturer's representative to provide detailed instructions to City's personnel for operation and maintenance of the specified equipment.

a. Training services include pre-startup classroom instruction, post-startup classroom instruction, and onsite equipment instruction, as stated in the Specifications.
b. Manufacturer's representative shall be familiar with plant O & M requirements as well as with the specified equipment.

Pre-startup Training: Coordinate pre-startup training periods with Owner's operating personnel and manufacturers' representatives, and with submittal of O & M Manuals.

a. Pre-startup training shall be completed at least 14 days prior to actual startup.
b. O & M Manuals shall be reviewed, accepted, and resubmitted, in accordance with Section SUBMITTALS, before startup.

Post-Startup Training: Where post-startup training is required in the Specifications, furnish and coordinate the specified manufacturers' services and Contractor's personnel for post-startup training of Owner's operating personnel.

2-12.11. Certificate Submittals. The forms included with this Section are to be used by the Contractor and by manufacturers of systems and products to certify proper installation, completion of functional testing, and performance testing results.

PART 3 – EXECUTION (NOT USED)

MANUFACTURER'S CERTIFICATE OF
PROPER INSTALLATION

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To verify installation recommendations and warranty is valid.

At a minimum, the following items (if applicable) must be checked:

	Yes	No	NA
Equipment serviced with proper lubricants.			
All safety equipment properly installed.			
Proper electrical connections.			
Proper mechanical connections.			
Equipment meets all warranty requirements.			

List additional items checked: (See Detailed Specification Section)

_____

_____

_____

_____

Comments: _____

_____

_____

(List and attach additional pages, if necessary.)

Signatures (Do not initial)

Contractor: _____ Date: _____

Manufacturer: _____ Date: _____

Engineer: _____ Date: _____

MANUFACTURER'S CERTIFICATE OF
FUNCTIONAL TEST ACCEPTANCE INSTALLATION

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To verify installation, that proper adjustments have been made, that the equipment or system is ready for plant startup and operation and warranty is valid.

At a minimum, the following items (if applicable) must be checked:

	Yes	No	NA
Rotation			
Alignment			
Speed			
Noise level			
Initial adjustments			
Initial calibration			

List additional items checked: (See Detailed Specification Section)

_____

_____

_____

_____

Comments: _____

_____

_____

(List and attach additional pages, if necessary)

Signatures (Do not initial)

Contractor: _____ Date: _____

Manufacturer: _____ Date: _____

Engineer: _____ Date: _____

MANUFACTURER'S CERTIFICATE
OF
PERFORMANCE TEST ACCEPTANCE

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To certify that the equipment or system identified above has been successfully tested for performance and is ready to be accepted by the City for full-time operation.

This certifies that the above equipment or system operated under actual performance conditions, and that the equipment or system meets the specified performance criteria.

Comments: _____

_____

_____

_____

(List and attach additional pages, if necessary)

Signatures (Do not initial)

Contractor: _____ Date: _____

Manufacturer: _____ Date: _____

Engineer: _____ Date: _____

CONTRACTOR'S CERTIFICATE
OF
EQUIPMENT START-UP READINESS

Contractor: _____

Equipment Name(s): _____

_____

_____

Equipment Tag Number(s): _____
_____

_____

Specification Section: _____

"I, the undersigned, do hereby certify that all of the necessary hydraulic structures, piping systems, and valves have been successfully tested; that all necessary equipment systems and subsystems have been checked for proper installation, started. and successfully tested to indicate that they are all operational; that the systems and subsystems are capable of performing their intended functions; and that the facilities noted above are ready for startup and intended operation."

_____	_____	_____
Signature	Title	Date

MANUFACTURER'S CERTIFICATE
OF
UNIT RESPONSIBILITY

Manufacturer: _____

Equipment Name: _____

Specification Section(s):_____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Purpose: To certify that the equipment or system manufacturer identified above accepts unit responsibility for equipment or systems furnished.

This certifies that the above equipment or system manufacturer accepts unit responsibility for equipment or systems furnished under the indicated specification section(s) and that the components furnished are compatible and comprise a functional unit suitable for the specified performance and design requirements.

Signatures (Do not initial)

Contractor: _____ Date: _____

Manufacturer: _____ Date: _____

End of Section

SECTION 01610

TRANSPORTATION HANDLING AND STORAGE

PART 1 - GENERAL

1-1. SCOPE.

1-1.01. The Contractor shall provide transportation of all equipment, materials and products furnished under these Contract Documents to the Work site. In addition, the Contractor shall provide preparation for shipment, loading, unloading, handling and preparation for installation and all other work and incidental items necessary or convenient to the Contractor for the satisfactory prosecution and completion of the Work.

1-1.02. All equipment, materials and products damaged during transportation or handling shall be repaired or replaced by the Contractor at no additional cost to the City prior to being incorporated into the Work.

1-2. TRANSPORTATION.

1-2.01. All equipment shall be suitably boxed, crated or otherwise protected during transportation.

1-2.02. Where equipment will be installed using existing cranes or hoisting equipment, the Contractor shall ensure that the weights of the assembled sections do not exceed the capacity of the cranes or hoisting equipment.

1-2.03. Small items and appurtenances such as gauges, valves, switches, instruments and probes which could be damaged during shipment shall be removed from the equipment prior to shipment, packaged and shipped separately. All openings shall be plugged or sealed to prevent the entrance of water or dirt.

1-3. HANDLING.

1-3.01. All equipment, materials and products shall be carefully handled to prevent damage or excessive deflections during unloading or transportation.

1-3.02. Lifting and handling drawings and instructions furnished by the manufacturer or supplier shall be strictly followed. Eyebolts or lifting lugs furnished on the equipment shall be used in handling the equipment. Shafts and operating mechanisms shall not be used as lifting points. Spreader bars or lifting beams shall be used when the distance between lifting points exceeds that permitted by standard industry practice.

1-3.03. Under no circumstances shall equipment or products such as pipe, structural steel,

castings, reinforcement, lumber, piles, poles, etc., be thrown or rolled off of trucks onto the ground.

1-3.04. Slings and chains shall be padded as required to prevent damage to protective coatings and finishes.

1-4. STORAGE. Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work.

1-4.01. Stacked items shall be suitably protected from damage by spacers or load distributing supports that are safely arranged. No metalwork (miscellaneous steel shapes and reinforcing steel) shall be stored directly on the ground. Masonry products shall be handled and stored in a manner to hold breakage, chipping, cracking, and spalling to a minimum. Cement, lime, and similar products shall be stored off the ground on pallets and shall be covered and kept completely dry at all times. Pipe, fittings, and valves may be stored out of doors, but must be placed on wooden blocking. PVC pipe, geomembranes, plastic liner, and other plastic materials shall be stored off the ground on pallets and protected from direct sunlight.

1-4.02. Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60°F. Electrical equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.

1-4.03. Equipment having moving parts, such as gears, bearings, and seals, shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer. Manufacturer's storage instructions shall be carefully followed by Contractor.

1-4.04. When required by the equipment manufacturer, moving parts shall be rotated a minimum of twice a month to ensure proper lubrication and to avoid metal to metal "welding". Upon installation of the equipment, Contractor shall, at the discretion of Engineer, start the equipment at one-half load for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

1-4.05. When required by the equipment manufacturer, lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment by Contractor at the time of acceptance.

1-4.06. Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

1-4.07. In addition to the protection specified for prolonged storage, the packaging of spare

units and spare parts shall be for export packing and shall be suitable for long-term storage in a damp location. Each spare item shall be packed separately and shall be completely identified on the outside of the container.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

End of Section

Section 01611

METEOROLOGICAL AND SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1. SCOPE. Buildings, non-structural components and non-building structures shall be designed in accordance with this section. In the event of conflict with requirements in other sections, the more stringent criteria shall be followed.

1-2. DESIGN CRITERIA. Buildings , non-structural components, non-building structures including anchorage of such items, shall be designed in accordance with the following criteria.

General Design Data:

Building code and references	IBC 2012, GA addendums, ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures", AISC 360 "Specification for Structural Steel Buildings", AISC 341 "Seismic Provisions for Structural Steel Buildings"	
Site elevation, above mean sea level - ICWRC	800 to 852	ft
Site elevation, above mean sea level - SRWRC	796 to 840	ft
Design flood elevation, DFE - ICWRC	802	ft
Design flood elevation, DFE - SRWRC	801	ft

Wind Design Data:

Basic wind speed, V	120	mph
Exposure category	C	
Importance factor (wind loads), I	1.00	

Snow Design Data:

Ground snow load, P_g	5	psf

Seismic Design Data for Building Structures

Occupancy Category	III
Design short period spectral response acceleration, S_{DS}	0.192
Design one second period spectral response acceleration, S_{D1}	0.142
Importance factor, I	1.25
Seismic Design Category	C

Seismic Design Data for Non-structural Components:

Design short period spectral response acceleration, S_{DS}	0.192
Component importance factor, I_P	As indicated in the Non-Structural Component Schedule
Seismic Design Category	C

1-3. WIND ANCHORAGE. Equipment that is to be located outdoors shall have anchor bolts designed for the effects of wind forces, as determined in accordance with ASCE 7, Chapter 6. Shop drawings shall include full anchor bolt details, and shall be sealed by a professional engineer licensed in the state of the project. Calculations shall be furnished when requested by Engineer.

1-4. SEISMIC DESIGN.

1-4.01. General. Structural systems shall provide continuous load paths, with adequate strength and stiffness to transfer all seismic forces from the point of application to the point of final resistance.

1-4.02. Pre-Engineered Buildings. Pre-engineered buildings shall have sufficient strength and ductility to resist the specified seismic effects defined for buildings and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code.

"W" for buildings shall include the total dead load, the total operating weight of permanent equipment and the effective contents of vessels, and applicable portions of other loads, as required by the specified building code.

1-4.03. Non-Structural Components. Non-structural components are architectural, mechanical, and electrical items that are permanently attached to and supported by a structure but are not part of the structural system, as indicated in Chapter 13 of ASCE 7, and in the Non-Structural Components Schedule.

The Non-Structural Components Schedule identifies the components that require some level of seismic design. The requirements of this paragraph are applicable only to the items listed in the Non-Structural Components Schedule.

All components, and the anchorage of those components to the main structure, shall be shown on construction documents prepared and sealed by a registered design professional that is licensed in the state of the project. The construction documents shall be submitted in accordance with the Submittal Procedures section. Structural calculations shall be submitted when requested by Engineer.

Design of non-structural components shall be in accordance with all applicable provisions of ASCE 7, Chapter 13. Non-structural components shall have sufficient strength and ductility to resist the specified seismic effects, and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code and other referenced codes.

Non-structural components shall be attached so that seismic forces are transferred to the structural system. Curbs that support roof-mounted equipment shall be designed to transfer forces from the equipment into the main structural roof members. All structural attachments shall be bolted, welded, or otherwise positively fastened. Frictional resistance due to gravity shall not be considered in evaluating the required resistance to seismic forces.

When the Non-Structural Components Schedule indicates that seismic design of any component is required, the component shall be designed to be operable during and following a design level seismic event without collapsing, breaking away from supports, creating an ignition hazard, or releasing any contents.
"W_p" shall include the total operating weight of the component or system, including, but not limited to, any insulation, fluids, and concentrated loads such as valves, condensate traps, and similar components.

Seismic effects that shall be analyzed in the design of piping systems include the dynamic effects of the piping system, contents, and supports. The interaction between piping systems and the supporting structures, including other mechanical and electrical equipment, shall also be considered. Where pipe supports are to be designed by Contractor, as required by the Pipe Supports section, both the piping and support systems shall be designed to meet the applicable requirements of ASCE 7, Chapter 13.

1-4.04. Non-Building Structures. Not Used.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

End of Section

Non-Structural Component Schedule				
Component	Applicable Specification Section	Importance Factor (I_p)	Design of Supports and Attachments	Design of Component
Steel Doors and Frames	08110	1.5	x	x
Floor Access Doors and Hatches	08305	1.5	x	x

Section 01615

EQUIPMENT AND VALVE IDENTIFICATION

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and installation of nameplates and tags for identification of equipment, valves, panels, and instruments.

1-2. GENERAL. Except as otherwise specified in equipment, valve, and instrumentation sections, nameplates and tags shall be as specified herein. Nameplates or tags shall be provided for all equipment, valves, operator interfaces, control and electrical panels, cabinets, instruments, and instrument racks that have been named and/or tagged on the Drawings.

1-3. SUBMITTALS. Drawings and data shall be submitted in accordance with the requirements of the Submittals Procedures section for each type of tag provided including materials, colors, sizes, letter sizes, and installation instructions.

PART 2 - PRODUCTS

2-1. EQUIPMENT NUMBER PLATES. All equipment tagged on the drawings, except for submerged equipment shall be provided with number plates bearing the equipment tag number identified on the Drawings. Number plates shall be bevelled, 1/8th inch thick laminated black phenolic plastic engraving stock with white core. Lettering on number plates shall be capitalized block letters ¾ inch high. Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be attached with 316 SS panhead screws, rivets, or drive screws.

When a number plate cannot be installed due to the physical size, space, or mounting surface geometry of the equipment, the Contractor shall provide a 12 gauge [2 mm] 316 SS tag with engraved or imprinted equipment tag number. Lettering on tags shall be ¼ inch [6.5 mm] high. Tags shall be rectangular with smooth edges, and shall be fastened to the equipment with 316 SS mechanical fasteners or with a 316 SS chain.

2-2. EQUIPMENT INFORMATION PLATES. Equipment shall be provided with engraved or stamped equipment information plates securely affixed with mechanical fasteners to the equipment in an accessible and visible location. Equipment information plates shall be in addition to the number plates specified.

Equipment information plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment information plates listing the distributing agent only will not be acceptable.

2-3. VALVE AND GATE TAGS.

2-3.01. Temporary Tags. Each valve and gate with an identifying number indicated on the Drawings or listed in the valve or gate schedule, shall be tagged or marked in the factory with the identifying number.

2-3.02. Permanent Tags. All valves and gates, except buried or submerged valves, that have been assigned a number on the Drawings or in the valve or gate schedule, shall be provided with a permanent number plate. Tags shall be permanently attached to valves and gates with 316 SS mechanical fasteners or with 316 SS chains. Numerals shall be ¾ inch high and shall be black baked enamel on an anodized aluminum plate.

All buried valves shall be tagged with a brass plate cast into a 6-inch by 6 inch concrete pad at grade next to the valve box. The valve number shall be engraved in the brass plate with lettering and numerals at least 1 inch high.

2-4. PANEL NAMEPLATES. Nameplates shall be provided on the face of each panel and cabinet. Panel identification nameplates shall be mounted at the top of the panel shall include the panel descriptive name and tag number as indicated on the Drawings, in two or three lines of text. Lettering shall be ¾ inch high.

Nameplates for devices mounted on or in the panel shall be inscribed with the text as indicated on the Drawings. Where nameplate information is not indicated on the Drawings, inscriptions shall be in accordance with information in the supplier's submittal drawings as guided by information in the relevant specification section. Panel device nameplates shall have engraved letters 3/16 inch high.

Nameplate material and size shall be as specified above for equipment number plates. Nameplates shall be secured to the panel with 316 SS panhead screws.

2-5. INSTRUMENT TAGS.

2-5.01. Temporary Tags. Where instruments are not provided with permanent tags furnished from the factory, instruments shall be tagged or marked in the factory with the instrument tag number indicated on the Drawings.

2-5.02. Permanent Tags. Instruments shall be tagged with the instrument tag number indicated on the Drawings. Tags shall be 12 gauge 316 SS with engraved or imprinted symbols. Lettering on tags shall be ¼ inch high. Tags shall be rectangular with smooth

edges, and shall be fastened to the instrument with 316 SS mechanical fasteners or with a 316 SS chain.

PART 3 – EXECUTION (NOT USED)

End of Section

Section 01640

MANUFACTURERS' SERVICES

PART 1 - GENERAL

1-1. DEFINITIONS.

1-1.01. Reference Section 01650, FACILITY STARTUP.

1-1.02. Man-Day: One person for 8 hours within regular Contractor working hours.

1-2. SUBMITTALS.

1-2.01. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

Preliminary Training Plan: Submit within 120 days after Notice to Proceed.

Training Schedule: Submit not less than 30 days prior to start of equipment installation and revise as necessary for acceptance.

Final Training Plan: Submit after training coordination meeting.

Training Materials: Submit written outlines of proposed training sessions not less than 30 days prior to scheduled training.

Furnish complete training materials, to include operation and maintenance data as required in this section. Provide 12 extra copies of all training materials to Owner.

Quality Control Submittals: When specified in the individual Specifications, submit:

Qualifications and resume of Manufacturer's Representative performing specified services.

Manufacturer's Certificate of Proper Installation: On form appended to this section.

1-3. QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE.
Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system. Additional qualifications may be specified elsewhere.

1-3.01. Representative subject to acceptance by City and Engineer. No substitute representatives will be allowed unless prior written approval by Engineer has been given.

1-4. FULFILLMENT OF SPECIFIED MINIMUM SERVICES.

1-4.01. Where manufacturers' services are specified, furnish manufacturer's qualified representative. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, additional time required to perform the specified services shall be considered incidental work.

1-4.02. Schedule manufacturer's services to avoid conflicting with other onsite testing or other manufacturer's onsite services.

Determine that all conditions necessary to allow successful testing have been met before scheduling services.

Only those days of service approved by Engineer will be credited to fulfill the specified minimum services.

If specified, manufacturer's onsite services shall be 8 hours minimum and include as a minimum:

Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.

Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish written approval of installation.

Revisiting the site as required to correct problems and until installation and operation are acceptable to Engineer.

Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.

Assistance during functional and performance testing and startup demonstration, and until product acceptance by the Owner.

Training of Owner's personnel in the operation and maintenance of respective product as required.

Completion of Manufacturer's Certificate of Proper Installation (form enclosed at end of this section) with applicable certificates for proper installation and initial, interim, and final test or service.

Additional requirements which may be specified elsewhere.

1-5. TRAINING PLAN.

1-5.01. Preliminary Training Plan. If specified, and within 120 days after Notice of Award, submit for each proposed course:

1. Title and objectives.
2. Training schedule.
3. Prerequisite training and experience of attendees.
4. Recommended types of attendees (e.g., managers, engineers, operators, maintenance).
5. Course description and outline of course content.
6. Duration.
7. Location (e.g., training center or site).
8. Format (e.g., lecture, self-study, demonstration, hands-on).
9. Instruction materials and equipment requirements.

1-5.02. Final Training Plan. Submit the following after training coordination meeting, if specified

1. Updated versions of course descriptions from preliminary training plan.
2. Who will attend each course.
3. Schedule of training courses including dates, durations, and locations of each class.
4. Detailed course schedule for each day showing time allocated to each topic.
5. Resumes of instructors providing the training.

1-6. TRAINING SCHEDULE

1-6.01. List specified equipment and systems with respective manufacturers that require training services of manufacturers' representatives and show:

1. Estimated dates for installation completion.
2. Estimated training dates to allow for multiple sessions when several shifts are involved.

1-6.02. Adjust training schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.

1-6.03. Coordinate with Progress Schedules as specified in Special Conditions and Section 01650, FACILITY STARTUP.

1-7. TRAINING CITY'S PERSONNEL

1-7.01. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information.

1-7.02. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.

1-7.03. Manufacturer's Representative. Familiar with plant operation and maintenance requirements as well as with specified equipment.

1-7.04. Pre-startup Training

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives.
2. Complete at least 7 days, but no more than 14 days, prior to actual startup.

1-7.05. Post-Startup Training. Furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives Manufacturer's representative shall be required for a follow-up visit of one day.

1-7.06. Taping of Training Sessions. The Owner will provide audio/video taping of all training sessions. Manufacturer's trainer is to provide appropriate props, such as, charts, photographs and samples in large enough sizes to be videotaped. All trainers are to provide their full cooperation to the Owner's video technician.

1-8. SUPPLEMENTS.

1-8.01. The supplements listed below, are part of this Specification.

1. Manufacturer's Certificate of Proper Installation.
2. Manufacturer's Instruction Certification Form.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

CITY OF ATLANTA - ICWRC DECOMMISSIONING AND
SRWRC CLARIFIERS AND AUXILIARY EQUIPMENT
MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO:_____

EQPT TAG NO:_____ EQPT/SYSTEM:_____

PROJECT NO:_____ SPEC. SECTION:_____

SITE LOCATION: _____

I hereby certify that the above-referenced equipment/system has been:
(Check Applicable)

☐	Installed in accordance with Manufacturer's recommendations.
☐	Inspected, checked, and adjusted.
☐	Serviced with proper initial lubricants.
☐	Electrical and mechanical connections meet quality and safety standards.
☐	All applicable safety equipment has been properly installed.
☐	System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)
☐	System has been started up and meets or exceeds performance requirements.

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date:_____

Manufacturer:_____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

CITY OF ATLANTA - ICWRC DECOMMISSIONING AND
SRWRC CLARIFIERS AND AUXILIARY EQUIPMENT
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 City operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)

Startup procedure reviewed	_____
Shutdown procedure reviewed	_____
Normal operation procedure reviewed	_____
Others: _____	_____
_____	_____

Maintenance Check List (check appropriate spaces)

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

_____ _____
Date Manufacturer

_____
Signature of Authorized Representative

Date	Signature of City's Representative
Date	Signature of Contractor's Representative

End of Section

SECTION 01650

FACILITY STARTUP

PART 1 - GENERAL

1-1. DEFINITIONS.

1-1.01. Pre-Operational Checkout (Step 1). Are those documented physical checks (tests) that must occur to insure that an item of equipment or equipment system is ready for functional testing. Example components of pre-operational checkout /testing include but are not limited to the following:

1. Pressure and/or leakage tests, water-tightness of concrete structures, and pipe testing.
2. Electrical testing, resistance testing in accordance with NETA - section 16T. Also, Phase/motor rotation checks.
3. Instrument calibration and loop tests. Pre-operational check-out of instrumentation system controls.
4. Pre-operational checkout of mechanical and HVAC equipment to include alignment, lubrication, and other checks as recommended by the manufacturer.

1-1.02. Functional Test: (Step 2). A test or tests, in the presence of the Engineer and City, to demonstrate that the installed equipment or system meets manufacturer's installation and adjustment requirements and other requirements.

The testing of the individual items of equipment within a system will be performed under simulated conditions to determine contract compliance. This test will utilize plant effluent, potable water, or another acceptable substitute test media. The equipment will be operated long enough to gather information (data) on noise, temperature, vibration, performance characteristics, and to make initial adjustments of any applicable controls. Initial baseline data will be gathered on equipment with motors greater than 1 horsepower including amperage, bearing temperatures, and vibration.

The instrumentation and control field testing (loop checks from the field devices to PLC or distributed control systems as well as field calibrations), will be accomplished during the pre-operational checkout and functional testing stages as defined above.

1-1.03. Operational Test (Step 3): A test, performed in the presence of the Engineer and City, of all components within a system collectively to insure that the system and all of its integral components function as intended. Water and/or other temporary media supplied by the Contractor will be circulated through the completed facility/system for 5 days with systems being operated under various loading conditions as proposed by the

Contractor and approved by the City's Engineer.

1. The instrumentation and control system automatic function for the overall system will be verified and documented during the operational testing stage as described above.

1-1.04. Punchlist. All items that could affect, or be affected by, the full time operation of the system (as deemed critical by the City Engineer) must be complete prior to the Operational Test phase.

1-1.05. Acceptance Test (Step 4). The start-up and operation of the systems installed, under actual operating conditions, as part of the actual plant process. The acceptance test period is 30 days. The City's O&M staff will be responsible for running the system with the Contractor's support team being available for assistance 24/7. Upon completion of this commissioning period the Contractor may apply for a Substantial Completion certificate.

1-1.06. Performance Test. Any special tests, performed in the presence of the Engineer and City, called for by the specific equipment or system specification which are to be performed in addition to the installation and acceptance tests noted in this start-up specification (pre-operational checkout, functional testing, operational testing, and acceptance testing).

1-1.07. System. The overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment. Examples of systems on this Project are as follows:

1. Pumps, motors, and controls.
2. Instrumentation and control system(s).

1-1.08. Substantial Completion. The date certified by the City Engineer when all or a part of the work as identified in the Engineer's certification, has been properly installed per the contract documents and manufacturer recommendations, deemed operational through the completion of the Pre-operational checkout, Functional Test, Operational Test, has all test documents with Operation and Maintenance manuals delivered, is sufficiently completed in accordance with the requirements of the Contract Documents and has been demonstrated through the 30 day Acceptance Test thus proving that the identified portion of the work can reliably be utilized for the purposes for which it is intended.

1-3. SUBMITTALS.

1-3.01. Administrative Submittals.

1. Functional and performance test schedules and plan for equipment, units, and systems at least 14 days prior to start of related testing. Include test plan, procedures, and log format.
2. Schedule and plan of facility startup activities at least 21 days prior to commencement.

1-3.02. Quality Control Submittals.

1. Manufacturer's Certificate of Proper Installation as required.
2. Test Reports: Functional and performance testing, in format acceptable to Engineer and certification of functional and performance test for each piece of equipment or system specified.
3. Certifications of Calibration: Testing equipment.

1-4. CONTRACTOR FACILITY STARTUP RESPONSIBILITIES.

1-4.01. General. The Contractor shall provide, at no expense to the City, all power, fuel, compressed air supplies, water, and chemicals; as well as all labor, temporary piping, heating, ventilating, and air conditioning or bypass pumping, for any areas where the Improved Facilities are not complete and operable at the time of Acceptance Testing and its prerequisites. Contractor shall provide all other items and work required to complete Acceptance Testing and its prerequisites. Temporary facilities shall be maintained until permanent systems are in service.

The Contractor shall also provide all necessary qualified operations personnel and manufacturers field service personnel of the major equipment suppliers on an eight hour per day basis at the facilities and on a 24 hour per day basis locally during the operational and acceptance test period.

At no time during startup shall the Contractor allow the facility to be operated in a manner which subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

1-4.02. Tie-Ins or Modifications To The Existing Systems. Anytime the Contractor ties into or modifies an existing system, a detailed work plan shall be required. Submittal of this work plan must be a minimum of 30 days in advance of commencement of the subject work. This work plan shall include a detailed description of the work, a step-by-step plan of the modification or tie-in, a detailed timeline schedule, a detailed list of materials and equipment required, demonstrated communications capacity, and a listing of any gates or valves which must be operated. Working drawings shall be submitted as required under GC-28 for any permanent or temporary structural modifications. A temporary safety plan covering the period of the work, and a listing of contingency plans and supplies, including but not limited to spill prevention planning and spill containment kits, shall be required. A coordination meeting with the City's plant operating staff, the Contractor, the Engineer and the Designer must be held at least 7 days prior to the

commencement of the modification or tie-in. The day before the commencement of the modification or tie-in, a final coordination meeting shall be held giving final detailed work assignments to all parties involved.

The City and Engineer have the right to require, at no additional cost to the City, stand-by equipment on any item(s) deemed critical enough to delay the work. The Contractor shall have available stand-by personnel to supplement the committed forces should problems arise. The Contractor is responsible for meeting all OSHA standards including entrance and exit safety, confined space entry, fall protection, scaffolding, rigging, etc.

1-4.03. Contractor's Startup Quality Assurance Manager. The Contractor shall appoint an operations engineer or equally qualified operations specialist as Startup Manager to manage, coordinate, and supervise all aspects of the Contractor's startup and testing program including, but not limited to those components of the program as listed with this appendix. The Startup Manager shall have at least five (5) years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum 4-year course in mechanical, civil or a related program of study. Operations specialists shall have equivalent documented experience in plant operation and maintenance. Contractor shall submit the Startup Manager's resume for review and approval a minimum of six months prior to any testing, or prior to 50% completion of the first constructed system.

1-4.04. Contractor's Testing Team. Contractor's Testing Team shall include at a minimum the Quality Assurance Manager, qualified Mechanical/Equipment Foreman, qualified Electrical Journeyman, qualified Instrument Technician, and qualified/Certified Plant Operations personnel.

Contractor is responsible to have the appropriate personnel, procedures, and test forms at the test site when performing a scheduled checkout/testing activity that is to be witnessed by the City Engineer.

1-4.05. Test Equipment. All test equipment (gauges, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus two (2) percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.

Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

Calibration equipment/test instruments utilized for start-up and testing shall be documented to include identification (by make, manufacturer, model, and serial number) of the test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory as well as documentation of current calibration

All analysis instruments, sensors, gauges, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration prior to Acceptance.

Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.

1-5. CITY/ENGINEER FACILITY STARTUP RESPONSIBILITIES.

1-5.01. General.

1. Review Contractor's test plan and schedule.
2. Witness each functional, operational (portions of) and performance test.
3. Coordinate other plant operations, if necessary, to facilitate Contractor's tests.

1-5.02. Startup Test Period.

1. Operate process units and devices, with support of Contractor.
2. Provide sampling, labor, and materials as required and provide laboratory analyses.
3. Make available spare parts and special tools and operation and maintenance information for City-furnished equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3-1. START-UP PROGRAM IMPLEMENTATION.

3-1.01. Start-Up Meetings. The Contractor shall schedule and conduct regular periodic start-up meetings (separate from regular progress meetings). The start-up meetings will be held at least every 10 days (once start-up planning commences) and may be scheduled at a more frequent interval by the City Engineer if necessary. Start-up meetings shall be held at a location designated by the Contractor and approved by the City Engineer.

Start-up meetings shall be attended by the City Engineer, Contractor, Subcontractors as appropriate to the agenda, suppliers as appropriate to the agenda and others as required.

The meeting agenda shall generally include review and approval of minutes of previous meeting, review of start-up progress since the previous meeting, field observations, problems, and conflicts, problems which impede Start-Up Schedule, delivery schedules, corrective measures and procedures to regain the start-up schedule, revisions to Start-Up Schedule, progress and schedule of the preceding work period, coordination of schedules, review of start-up submittal schedules and status, status of start-up related requests for information, and any other business deemed appropriate.

3-1.02. Start-up and Testing Schedule. The Contractor shall produce an overall testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Construction Schedule. The testing schedule shall show the contemplated start date, duration of the test and completion of each test.

The preliminary test schedule shall be submitted with the overall Start-up Acceptance Test Plan. The City Engineer will not witness any testing work until the Contractor has submitted a schedule to which the City Engineer takes no exception. The test schedule shall be updated weekly, and presented at each start-up meeting, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of the Contract Standards, and also re-forecast the upcoming testing and reflect any schedule adjustments accompanied by written reason for the change. The Contractors baseline start-up and testing schedule is to be submitted with the overall test plan.

3-1.03. Documentation. The Contractor shall develop a records-keeping system to document all activities associated with Acceptance Testing and its prerequisites.

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 witness by the City Engineer, the Contractor's Start-Up/Quality Assurance Manager, and the Equipment Manufacturer. A separate file shall be established for each system, organized by start-up phase (i.e., pre-operational, functional, operational, acceptance test phase), and will include sections for each item of equipment. These files shall include the following information and documentation as a minimum. Test plan and documentation organization shall be as follows:

3-1.04. Test Plan Organization.

1. Index.
2. Schedule

3. Step 1 & 2: Each type of equipment will have its own section within the system and include the following:
   a. The detailed pre-operational test procedures.
   b. The detailed functional test procedures.
   c. Customized mechanical equipment, customized electrical, and customized instrumentation pre-operational and functional test forms as applicable.
   d. Other pre-operational test documentation as required for piping and mechanical equipment.

4. Step 3: A separate section will be created for the system operational testing and include the following:
   a. The detailed 5 day operational test procedure.
   b. A detailed operational system check/sign-off sheet (based on system tests, control checks, and interlock checks to be performed).
   c. System operational test completion sign-off form.

5. Step 4: Another section is to be designated for the Acceptance Testing and include the following:
   a. Detailed work plans, communications plan, safety plan, and contingencies, as well as other requirements outlined under tie-ins and modifications to existing systems (SC-24).
   b. 30 day test overview and proposed spreadsheet forms to be utilized by the Contractors staff to record appropriate operational and performance data on a regular interval for the 30 days.
   c. System acceptance test completion/sign-off form.

The forms attached to this Appendix are samples showing the required format and level of detail for documentation. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable example documentation forms for all systems and items of equipment shall be produced and submitted for review and approval by the City Engineer [as a condition precedent to the Contractor's receipt of progress payments in excess of 60 percent of the contract amount]. Once the City Engineer has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce customized forms for each item of equipment and system and include these individual forms in the overall test plan that will be submitted for approval.

The complete test plan and all its sections are to be submitted (60 days prior to any testing) and approved, Code 1 or Code 1C, prior to the start of any testing.

3-2. TEST PLAN IMPLEMENTATION. This program will be implemented in 4 distinct steps (phases). These steps are the Pre-Operational Checkout, the Functional Testing, the Operational Testing, and the Acceptance Testing.

3-3. STEP 1 - PRE-OPERATIONAL CHECKOUT AND TESTING.

3-3.01. The first step involves the Pre-operational checkout. This would include multi-discipline work completion and physical checkout .The Pre-operational Completion Verification and Pre-operational test reports include the following required testing. Examples of these documented tests include, but are not limited to:

1. Field pressure/leakage test reports for all pipe, valves, and appurtenances.
2. Wire insulation megohm reports for all 120V and greater wire.
3. Phasing, ratio, polarity, ground resistance, current injection, insulation resistance, over potential test, and circuit breaker contact resistance reports for medium voltage switchgear.
4. Insulation power factor and resistance test reports for surge arresters.
5. Megger reports for Unit Substations, Three Winding Transformers, and 4160V motor control centers.
6. Megger reports and ground connection tests.
7. Loop Status Report and Component Calibration forms.
8. Equipment installation checkout forms.

3-3.02. Pipe Testing. Prior to application of insulation on exposed piping, test the piping systems at the appropriate pressure according to the requirements of related piping specifications. All buried piping shall be tested prior to any backfill being placed, unless prior approval by the Engineer is given in writing. Test duration shall be one-hundred twenty (120) minutes for all tests and witnessed by a City Engineer. Isolate equipment that may be damaged by the specified test conditions. 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. Testing shall include existing piping systems that connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping that fails the test shall be repaired.

For gas, air, and vapor systems, the allowable leakage rate for systems tested with air shall be based on a maximum pressure drop of 5 percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure. The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include sulfur dioxide, chlorine, propane, sludge gas and natural gas systems. Testing medium shall be as follows for gas, air, and vapor systems:

Pipeline size	Specified test pressure	Testing medium
2 inch and smaller	75 psi or less	Air or water

2 inch and smaller	Greater than 75 psi	Water
Greater and 2 inch	3 psi or less	Air or water
Greater and 2 inch	Greater than 3 psi	Water

For liquid systems, leakage shall be zero at the specified test pressure throughout the specified duration for exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. 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. Drain systems, other than pumped drain systems, shall be tested in accordance with Georgia State Minimum Standards.

For hydraulic and lube oil systems, upon completion of cleaning, all field connections shall be completed and the system tested at the specified pressure. Pressure loss shall be zero for the specified test period. For fluid power systems, the manufacturer shall supervise the installation and testing of all system components including all field piping.

3-3.03. Pipe System Cleaning and Flushing. Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating or instrumentation equipment. The Contractor may, at his option, clean and test sections of 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.

Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs that remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 to 1	1/16
1-1/4 to 3	1/4
3-1/2 to 6	1/2
Over 6	1

The Contractor shall maintain the screens during all testing prior to the start of Acceptance testing. In special cases, screens may be removed as required for performance tests. Prior to the start of Acceptance Testing, the Contractor shall 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.

Gas and air system piping 6 inches in diameter and smaller shall be blown out, using air

or the testing medium specified. Piping larger than 6 inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an air stream. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psig until the piping is placed in service.

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. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide certificate of compliance that the ACL has been met.

3-3.04. Equipment – Pre-Operational Checkout. Equipment pre-operational checks and tests shall include, but are not limited to, the following:

1. Check for proper installation, alignment, support, and anchorage per the applicable manufacturers operation and maintenance manual and in accordance with the contract documents.

2. Check the equipment for proper adjustment, packing of seals, lubrication, drive connection, motor connection, and belt/chain tension per the applicable manufacturers operation and maintenance manual and in accordance with the contract documents.

3. Check the associated process, seal water, drain, and vent pipe connections for proper routing and connection. Check to insure the pipe testing was performed and signed as completed for all the associated piping.

4. Insure that the equipment is clean and free of any construction debris that could potentially cause a malfunction.

5. Insure that all safety guards, signage, and other safety measures such as hearing protection, etc., are in place.

6. Have the manufacturer's representative perform all pre-operational tests per the manufacturers' recommendations and review the equipment installation and sign the Manufacturer's Installation portion of the certification form. If the manufacturer's representative brings his own checklist, obtain a copy of the completed form and attach it to the Contractors completed forms. Note that the manufacturer must also fill out the contract approved checkout form (their own form will not serve as a substitute).

7. All gates and valves associated with the equipment system must be checked for proper installation, adjustment, and lubrication per the manufacturer's recommendations.

3-3.05. Concrete Tanks – Pre-Operational Checkout. All water-retaining concrete structures shall be tested for watertightness in accordance with ACI 350.1R. The maximum allowable leakage rate shall be 0.075% over a 24-hour period.

3-3.06. Electrical Pre-Operational Checks/Tests. Prior to energizing electrical circuits, use a 1,000-volt megohmeter to measure insulation resistance on conductors and insulated parts of electrical equipment. All measurements shall meet or exceed the appropriate ICEA, NEMA, or ANSI standard. Any insulation resistance less than 10 megohms is unacceptable. Record results, as well as ambient temperature. See attached form for example.

Measure phase-to-ground insulation resistance for all circuits 120 volts and above, with the exception of lighting circuits. Measurements may be made with motors and other equipment connected, except that solid state equipment shall be disconnected unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.

Complete Test Form for each installed motor. Measure the insulation resistance of all motors before connection. Measure the insulation resistance for all motors at the time of delivery as well as when connected. Insulation resistance values less than 10 megohms are not acceptable.

Adjust and make operative all protective devices. Perform a functional check of the control circuit prior to energization of the equipment.

Review all associated electrical terminations, switches, and breakers for satisfactory installation.

3-3.07. Individual Component/Instrument Calibration Pre-Operational Check/Test.

Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test report form.

Alarm trips, control trips, and switches shall be set to initial values specified in the design at this time. Final elements shall be checked for range, dead band, and speed of response.

Calibration of analysis instruments, sensors, gauges, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system operational, performance or acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the City's Engineer.

Testing of instrument process piping/tubing, wiring and individual components shall be completed and documented on the approved test forms provided to the City Engineer as part of the pre-operational testing phase and prior to commencement of individual loop testing conducted during the pre-operational functional test phase.

Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

System instrumentation equipment supplied and installed must also be reviewed for proper installation and termination as part of the pre-operational checkout.

3-3.08. Pre-Operational Checkout Summary. The pre-operational checkout and testing for each item shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved pre-operational test forms.

The Contractor shall complete the pre-operational testing requirements listed above, at a minimum, for each item of mechanical, electrical, instrumentation, and HVAC equipment prior to beginning any functional testing with regard to the equipment or the systems in which the equipment functions.

3-4. STEP 2 - FUNCTIONAL TEST.

3-4.01. General. The second step in the program is the Functional Test. This is the functional testing of the equipment. These tests begin for each item of equipment only after the Pre-operational Checks have been completed for all components for the particular equipment.

The functional testing for each item of equipment shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved functional test forms.

Once 1) all affected equipment has been subjected to the required pre-operational

testing procedures; and 2) the City 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 Contract Standards. If available, plant process media may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated for 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. 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, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the City. Disposal methods for test media shall be subject to review by the City Engineer. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for use in the CMMS.

Test results shall be within the tolerances set forth in the detailed specification sections of the Contract Documents and as indicated in the Contractors functional test plan and the manufacturers criteria. 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 functional test, any doubt, dispute, or difference should arise between the City Engineer and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the City Engineer may order the test to be repeated at the Contractors expense. Where the results of any functional test fail to comply with the Contract Standards for such test, then such repeat tests as may be necessary to achieve the Contract Standards shall be made by the Contractor at his expense.

3-4.02. The Functional Test reports (test documentation) include the required testing. Examples of these types of reports include, but are not limited to:

1. The Functional Field Test of valves.
2. The cycling/functions check of the sluice gates, slide gates, weir gates, stop logs, and stop plates.
3. The leakage testing of sluice gates, slide gates, weir gates, stop logs, and stop plates in accordance with AWWA specifications.
4. Vibration, noise, and capacity testing of Pumps.
5. Air distribution and leakage test of any diffused air systems.
6. Loop functional test for Instrumentation and Control.

3-4.03. Process/Mechanical/Equipment – (Functional Testing). During the Functional Verification Check and Testing process, the Contractor and the various Manufacturers'

Technical representatives shall examine and record the initial start-up performance of the components provided by their respective firms in accordance with the Contractors approved functional test procedure.

The initial operation, testing and adjustment shall be as required to prove that the equipment has been installed properly and operates under the conditions specified.

Upon completion of this work, the manufacturer's field service technician shall complete the Contractors approved functional test form as well as their own signed report to record the results of his/her inspection, operation, adjustments and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results if such are specified, and suggestions for precautions to be taken to ensure proper maintenance.

3-4.04. Electrical - (Functional Testing). The Contractors' electrician shall be present during all testing to confirm the electrical, provide troubleshooting assistance, repair as needed, and assist in gathering baseline data such as motor amperages.

Energize each control circuit and operate each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. The Contractor shall submit a description of his proposed functional electrical test procedures as part of the testing plan.

Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

3-4.05. Instrumentation and Control – (Functional Testing). The Contractors' instrumentation representative shall be on site full time during the functional test phase to perform loop checks and to support the Contractors start-up team as needed. Any packaged equipment or manufacturer supplied control panels must be field tested to verify all control interlocks and control functions during this phase of testing by the equipment supplier. Note that the Contractors functional test procedure for each piece of equipment shall define each interlock to be tested.

Each instrument loop shall be tested. This testing shall check operation from transmitter to readout components. Signals shall be generated utilizing the primary measuring elements where possible. Signals shall be injected only if primary element is unavailable.

If any output device fails to indicate properly, corrections to the loop shall be made as necessary and the test repeated until all instruments operate properly.

3-4.06. Functional Testing Summary. The functional testing for each item of equipment, electrical, and instrumentation shall be carried out in accordance with the

Contractors submitted and approved procedures and documented on the Contractors approved functional test forms.

3-5. STEP 3 – OPERATIONAL TESTING.

3-5.01. The third step in the program is the Operational Testing. This step begins after all Pre-operational checks and Functional tests have been satisfactorily completed. The Contractor shall plan his activities to allow for City witnessing of all tests and shall provide twenty-four (24) hours advance notice of all testing activities.

3-5.02. The Contractors operational test plan shall be a detailed procedure to confirm all System Automatic Mode functions, verify all system interlocks, and reconfirm all equipment functions and controls. All design and performance criteria will be demonstrated and documented during this 5 day period. The Contractors manufacturer, electrical, and instrumentation representatives will be on site on an 8 hour a day basis and locally on a 24 hours a day basis during this period.

3-5.03. In the event of failure to demonstrate satisfactory performance of the system on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. When the system is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the system has operated continuously to the satisfaction of the City and Engineer, for the specified duration.

3-6. STEP 4 – ACCEPTANCE TESTING.

3-6.01. The fourth step in the program is Acceptance Testing. The acceptance test period shall not begin until all new systems and equipment have successfully completed the operational test period.

3-6.02. The Operations and Maintenance staff shall receive spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data and the specified operation and maintenance instruction prior to the startup with plant process media. All valve tagging shall also be complete prior to this startup.

3-6.03. As part of the acceptance test plan the Contractor shall submit detailed work plans, communications plan, safety plan, contingencies, and other requirements as outlined under tie-ins and modifications to existing systems (SC-24). Also a 30 day test overview and proposed spreadsheet forms to be utilized by the Contractors operations staff to record appropriate operational and performance data on a regular interval for the 30 days.

3-6.04. Prerequisites. Prior to the City's issuance of a Certificate of Substantial Completion for all Design/Build Improvements, the contractor shall perform Acceptance

Testing. Acceptance Testing and the Acceptance Test Plan shall comprehensively cover all potential modes of operation, including failure scenarios, as well as the operation of ancillary systems, to demonstrate full functionality of the Improved Facilities. Any failures of process, equipment or systems shall result in re-starting the acceptance testing period. The testing period shall be a minimum of 30 days of continuous operation, during which the facility must meet the following criteria:

1. Continuous satisfactory operation at the rated capacity;
2. Operation without violating the Contract Standards;
3. Operation without creating a materially unsafe condition, nuisance condition or unacceptable risk to personnel, facilities or the public;
4. Operation without producing Biosolids products, air or water emissions, traffic, noise, odors, or other environmental impacts that the City, in its sole discretion, determines to be unacceptable to public safety, health or welfare.
6. All portions of the acceptance test phase will be carried out by qualified/certified operations personnel (supplied by the Contractor) that have a thorough knowledge of the process and can fully implement and document the facility performance as well as the Contractors acceptance test plan.

3-6.05. Instrumentation Acceptance Test. The instrument loop acceptance test shall fully demonstrate stable operation of the loop under normal operating conditions. This test shall be witnessed by a City Engineer and performed and documented by the Instrumentation System Supplier.

Tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop shall be adjusted to provide 1/4 amplitude damping unless otherwise specified and witnessed during system supplier factory testing.

3-6.06. Flow Meters. Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than 2 inches shall be calibrated insitu using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated insitu using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range and witnessed by a City Engineer. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus 2 percent.

3-6.07. In the event of failure to demonstrate satisfactory performance of the system on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. When the system is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the system has operated continuously to the satisfaction of the City and Engineer, for the specified duration.

3-6.08. All completed operational test forms will be placed into the master record test plan binder and provided to the City of Atlanta prior to acceptance.

End of Section

SECTION 01664

TRAINING

PART 1 – GENERAL

1-1. DESCRIPTION. This section contains requirements for training the City's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this Contract.

1-2. QUALITY ASSURANCE. Where required by the detailed specifications, the Contractor shall provide on-the-job training of the City's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1-3. SUBMITTALS.

1-3.01. The following information shall be submitted to the City's Engineer in accordance with paragraph GC-31 of the GENERAL CONDITIONS. The material shall be reviewed and accepted by the City's Engineer as a condition precedent to receiving progress payments in excess of 75 percent of the Contract amount and not less than 3 weeks prior to the commencement of training.

1. Lesson plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 - PRODUCTS

2-1. GENERAL. Where specified, the Contractor shall conduct training sessions for the City's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work after the equipment has been installed and tested and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

2-2. LOCATION. Training sessions shall take place at the site of the work.

2-3. LESSON PLANS.

2-3.01. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

2-3.02. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the City and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2-4. FORMAT AND CONTENT.

2-4.01. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization:
   a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
   b. Check out the installation of the specific equipment items.
   c. Demonstrate the installed unit and indicate how all parts of the specifications are met.
   d. Answer questions.
2. Safety:
   a. Using material previously provided and installed equipment, review safety references.
   b. Discuss proper precautions around equipment.
3. Operation:
   a. Using material previously provided and installed equipment, review reference literature.
   b. Explain all modes of operation (including emergency).
   c. Check out City's personnel on proper use of the equipment.
4. Preventive Maintenance:
   a. Using material previously provided and installed equipment, review preventive maintenance (PM) lists including:
      i. Reference material.
      ii. Daily, weekly, monthly, quarterly, semi-annual, and annual jobs.
   b. Show how to perform PM jobs.
   c. Show City's personnel what to look for as indicators of equipment problems.

5. Corrective Maintenance:
    a. List possible problems.
    b. Discuss repairs; point out special problems.
    c. Open up installed equipment and demonstrate procedures, where practical.
6. Parts:
    a. Show how to use previously provided parts list and order parts.
    b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
7. Local Representatives:
    a. Where to Order Parts: Name, address, and telephone.
    b. Service Problems:
        i. Who to call.
        ii. How to get emergency help.
8. Operation and Maintenance Manuals:
    a. Review any other material submitted.
    b. Update material, as required.

2-5. VIDEO RECORDING. The City will retain the services of a commercial video taping service to record each training session. After taping, the material may be edited and supplemented by the City with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be video taped and shall make available to the City's videotaping Contractor such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3 – EXECUTION

3-1. GENERAL.

3-1.01. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Contractor/Manufacturer is to plan for up to three classes in any 24 hour period to ensure all shifts are properly trained

3-1.02. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the City prior to the start of any training. Video taping shall take place concurrently with all training sessions.

3-1.03. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum classroom equipment training for operations personnel will include:
   a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
   b. Purpose and plant function of the equipment.
   c. A working knowledge of the operating theory of the equipment.
   d. Startup, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
   e. Identify and discuss safety items and procedures.
   f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
   g. Operator detection, without test instruments, of specific equipment trouble symptoms.
   h. Required equipment exercise procedures and intervals.
   i. Routine disassembly and assembly of equipment if applicable (as judged by the City on a case-by-case basis) for purposes such as operator inspection of equipment.
2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      i. Location of primary element.
      ii. Location of instrument readout.
      iii. Discuss purpose, basic operation, and information interpretation.
   e. Discuss, demonstrate, and perform standard operating procedures and routine checks.
   f. Discuss and perform the preventative maintenance activities.
   g. Discuss and perform startup and shutdown procedures.
   h. Perform the required equipment exercise procedures.
   i. Perform routine disassembly and assembly of equipment if applicable.
   j. Identify and review safety items and perform safety procedures, if feasible.
3. Classroom equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Startup and shutdown procedures.

d. Normal and major repair procedures.
e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
f. Routine and long-term calibration procedures.
g. Safety procedures.
h. Preventative maintenance such as routine lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform startup and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform City approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

End of Section

SECTION 01800

MAINTENANCE

PART 1 - GENERAL

1-1 DESCRIPTION.

1-1.01. Contractor will be required to maintain stored and installed equipment and materials until Final Acceptance of the Work as defined by the General Conditions. Work included, but is not limited to:

1. Perform all required maintenance.
2. Repair and maintain protective coatings.
3. Repair and replace scratched and damaged materials and equipment.
4. Maintain and operate new equipment placed into service.

1-1.02. Work per this Section starts on the date the equipment and materials are received and continued until the Date of Final Acceptance.

1-1.03. Contractor will monitor equipment storage and subsequently the operation and material functionality on a continual basis during the specified time period. Any deterioration of materials or malfunction of equipment will be followed by swift repair action to minimize the damage. Such repair may include repair and technical services by an independent contractor if the Engineer deems the Contractor's efforts are ineffective in correcting the problem.

1-1.04. All costs for maintenance and repair of stored and installed equipment and materials, including costs from an independent contractor, during the specified time period will be the sole responsibility of the Contractor.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

End of Section

SECTION 02000

SITE WORK

PART 1 - GENERAL

1-1. DESCRIPTION.

1-1.01. These general site work requirements apply to all site work operations. Refer to specification sections for specific product and execution requirements.

1-2. QUALITY ASSURANCE.

1-2.01. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.

1-2.02. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

1-3. PROJECT CONDITIONS.

1-3.01. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services designated to remain. Repair utilities damaged during site work operations at Contractor's expense.

1-3.02. Arrange for disconnection and seal or cap all utilities and services designated to be removed before start of site work operations. Perform all work in accordance with the requirements of the applicable utility company or agency involved.

1-3.03. When uncharted or incorrectly charted underground piping or other utilities and services are encountered during site work operations, notify the Engineer and the applicable utility company immediately to obtain procedure directions. Cooperate with the applicable utility company in maintaining active services in operation.

1-3.04. Locate, protect, and maintain bench marks, monuments, control points and project engineering reference points. Reestablish disturbed or destroyed items at Contractor's expense.

1-3.05. Perform site work operations and the removal of debris and waste materials to assure minimum interference with streets, walks, and other adjacent facilities.

1-3.06. Obtain governing authorities' written permission when required to close or obstruct street, walks and adjacent facilities. Provide alternate routes around closed or obstructed traffic ways when required by governing authorities.

1-3.07. Control dust caused by work. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

1-3.08. Protect existing buildings, paving, and other services or facilities on site and adjacent to the site from damage caused by site work operations. Cost of repair and restoration of damaged items at Contractor's expense.

1-3.09. Protect and maintain street lights, utility poles and services, traffic signal control boxes, curb boxes, valves and other services, except items designated for removal. Remove or coordinate the removal of traffic signs, parking meters and postal mail boxes with the applicable governmental agency. Provide for temporary relocation when required to maintain facilities and services in operation during construction work.

1-3.10. Preserve from injury or defacement all vegetation and objects designated to remain.

PART 2 - PRODUCTS

2-1. MATERIALS AND EQUIPMENT.

2-1.01. Materials and equipment: As selected by Contractor, except as indicated in contract documents.

PART 3 - EXECUTION

3-1. PREPARATION.

3-1.01. Examine the areas and conditions under which site work is performed. Do not proceed with the work until unsatisfactory conditions are corrected.

3-1.02. Consult the records and drawings of adjacent work and of existing services and utilities which may affect site work operations.

End of Section

Section 02050

DEMOLITION

PART 1 - GENERAL

1-1. SCOPE. This section covers the demolition of existing structures, pipingequipment, and sitework and the salvage of existing materials and equipment as specified herein.

1-2. GENERAL. Contractor shall be responsible for all work under this section. Contractor shall provide 14 days written notice prior to beginning demolition activities.

All structures and facilities of the existing Intrenchment Creek and South River WRC, which are not to be removed must remain in continuous operation during the work. Demolition and salvage work shall create minimum interference with Owner's operations and minimum inconvenience to Owner. Contractor shall provide protection and safety of all roadways, sidewalks, and all accessible areas during demolition activities.

Blasting will not be permitted.

1-3. SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1-3.01. The Contractor shall submit to the Engineer, prior to beginning work, a schedule of demolition and detail methods to be used on each facility to be demolished.

1-3.02. The Contractor shall develop and submit a demolition plan which includes a demolition schedule comparable to a room finish schedule that covers:

1. Each building surface affected by demolition.
2. Proposed method and materials for demolition and patching.
3. Catalog cuts and samples of the materials to be used.

PART 2 - PRODUCTS

2-1. MATERIALS.
2-1.01. The Contractor shall provide all materials and equipment in suitable and adequate quantity as required to accomplish the work shown, specified herein, and as required to complete the project.

2-1.02. All concrete, mortar, grout, and backfill used in patching, plugging or repairing shall comply in all respects with the applicable material requirements of these Specifications.

2-1.03. Tile and brick used for the patching of existing masonry shall be of the same size, color and texture as the tile and brick which they abut. Salvageable tile and brick units which are removed in performing the required alterations may be reused if the exposed faces and edges of the units are in good condition. If satisfactory units are unobtainable through salvage operations, the Contractor shall furnish the required units of new material of similar quality, color and texture.

PART 3 - EXECUTION

3-1. GENERAL.

3-1.01. Shutdown of Existing Operations and Utilities.

The Water Reclamation Centers are required to remain in service during construction of the new and modification of the existing facilities.

Total shutdown of the existing facilities to perform any new construction, to make the required structural or piping modifications, and, and/or to make or install the required electrical service or system modifications, will not be permitted.

Prior to making any piping or structural connections or modifications to existing facilities, obtain specified timing and schedule approval.

3-1.02. Protection.

Take care to prevent the spread of dust and flying particles. Sprinkle rubbish and debris with water to keep dust to a minimum.

Maintain adequate fire protection, including extinguisher and operative water-hose lines during demolition.

Perform work by personnel experienced in this type work and in such a manner as to eliminate hazards to persons and property without interference with new work and with use of adjacent areas, public rights-of-way, utilities and structures.

3-2. DEMOLITION. Removal of equipment or facilities shall include removal of all accessories, piping, wiring, supports, associated electrical starters and devices, baseplates and frames, and all other appurtenances, unless otherwise directed. Existing materials and equipment removed, and not indicated to be reused as a part of the Work,

shall become Contractor's property unless otherwise specified, and shall be removed from the Site.

Contractor shall conduct demolition activities in a manner that prevents damage to existing facilities which are indicated to remain and shall provide all necessary protection for existing facilities. Any remaining facilities damaged during demolition shall be repaired by Contractor to a condition equal to or better than the original condition.

When demolition is complete, all debris shall be removed from the Site and the Site graded to the lines and grades indicated on the Drawings.

3-2.01. Structure Demolition.
The following structures at the Intrenchment Creek and South River WRC shall have their basin covers demolished. This effort is considered an additive alternative.

Structure Demolition	
Intrenchment Creek WRC	Digester 1

3-2.02. Complete Demolition Areas.

The following structures at the Intrenchment Creek and South River WRC shall be completely demolished, including the base slab or floor:

Complete Demolition	
Intrenchment Creek WRC	Trickling Filter
South River WRC	Acetic Acid System
	1936 Control Building
	Gravity Thickeners
	Digesters 1-3
	Digester Control Building 1
	DAF Facility
	DAF Polymer Building

3-2.03. Piping and Equipment Demolition.
Piping and equipment, as shown on the drawings, shall be removed and shall become the property of Owner. All such items shall be promptly removed from the jobsite.

3-2.04. Sitework Demolition. Sitework demolition shall include the following:

Removal of reinforced and nonreinforced concrete drives, pavement, sidewalks, curb, and slabs on grade within the limits indicated on the Drawings.

Removal of asphaltic concrete pavement within the limits indicated on the Drawings.

Removal of reinforced concrete retaining walls within the limits indicated on the Drawings and to an elevation 5 ft below finished grade.

Removal of trees and shrubs indicated on the Drawings to be removed and as required to complete the work.

Removal of the manhole tops, risers, and rings and covers for the manholes indicated on the Drawings.

Removal of the top slabs from the manholes indicated on the drawings

Removal of basin covers and walls, to an elevation 5 ft below finished grade.

In water containing process basins, complete removal of a minimum of 10% of the basin floors to facilitate drainage.

Complete removal of basins where new structures are to be constructed.

Removal of all abandoned power and telephone poles.

Removal of all riprap to an elevation 5 ft below finished grade.

Removal of existing fencing within the limits indicated on the Drawings.

Removal of existing yard piping within the limits indicated on the Drawings. All 12 in and larger yard piping indicated to be abandoned shall be plugged with concrete.

3-3. SALVAGE.

3-3.01. Items to Be Salvaged by Owner. Not used.

3-3.02. Items to Be Salvaged by Contractor. Unless otherwise indicated in the drawings, no items need to be salvaged by the Contractor. Disposal of all demolition items will be the responsibility of the Contractor.

End of Section

SECTION 02110

CLEARING AND GRUBBING

PART 1 - GENERAL

1-1. SCOPE.

1-1.01. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for all clearing and grubbing including, but not limited to, the removal from the Site of trees, stumps, roots, brush, structures, abandoned utilities, trash, debris and all other materials found on or near the surface of the ground in the construction area and understood by generally accepted engineering practice not to be suitable for construction of the type contemplated.

1-1.02. The extent of route clearing is that minimum degree of clearing necessary to carry out all construction activities including construction of appurtenances and other additional clearing needed for access purposes.

1-1.03. Clearing and grubbing operations shall be coordinated with temporary and permanent erosion control requirements.

1-1.04. Clearing operations include, but are not limited to, the following:

1. Protection of existing trees and other vegetation
2. Removal of trees and other vegetation
3. Clearing
4. Removing above-grade improvements
5. Removing underground improvements
6. Restoring damaged improvements
7. Protecting above-grade and underground improvements
8. Erosion control of disturbed areas

1-2. JOB CONDITIONS.

1-2.01. Protection of Existing Improvements: Provide barricades, coverings, or other types of protection necessary to prevent damage to existing improvements.

Protect improvements on adjoining properties as well as those on the project site. Restore improvements damaged by this work to their original condition, as acceptable to the Engineer. Replace property line monuments (such as iron pins) removed or disturbed by clearing operations under the direction of a Land Surveyor licensed in the State of Georgia.

1-2.02. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation to avoid cutting, breaking or skinning of roots, skinning and bruising of bark,

smothering of trees by stockpiling construction materials or excavated materials within drip lines, foot or vehicular traffic, and parking of vehicles or equipment within drip line. Provide temporary fences, barricades or guards as required to protect trees and vegetation to be left standing.

Provide protection for tree roots over 1-1/2 inches diameter that are cut during any construction operation. Coat the cut faces with emulsified asphalt, or other acceptable coating, especially formulated for horticultural use on cut or damaged plant tissues. Temporarily cover all exposed roots of trees with wet burlap to prevent roots from drying out; provide earth cover as soon as possible.

Repair or replace damaged trees and vegetation resulting from any construction operation, in a manner acceptable to the Engineer. A qualified arborist approved by the engineer shall perform tree damage repair at no cost to the City. Replace damaged trees that cannot be repaired and restored to full-growth status, as determined by the Engineer.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3-1. EXISTING TREES AND VEGETATION.

3-1.01. Avoid cutting or injuring trees and vegetation outside easement line and outside areas to be cleared, Contractor shall be responsible for damages outside these lines.

3-2. CLEARING AND GRUBBING.

3-2.01. Clearing operations shall begin no more than seven days before beginning construction work for any area.

3-2.02. Materials to be cleared, grubbed and removed from the project site include but are not limited to vegetation, trees, stumps, roots, lawns, shrubbery, gardens, paving, miscellaneous structures, debris, and abandoned utilities to the minimum practicable extent to complete the work. Limit clearing to a single lane work route without provision for construction vehicles to pass utility operation. Determine and stake limitations of construction easement or right-of-way prior to commencement of work and keep construction activity within such limits.

3-2.03. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all areas to be graded so that topsoil is free of roots and debris. Topsoil is to be left sufficiently clean so that further picking and raking will not be required.
3-2.04. All stumps, roots, foundations and planking embedded in the ground shall be removed and disposed of. Stumps and roots larger than 1 inch shall be grubbed and removed to a depth not less than 4 feet below grade. All holes or cavities which extend

below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to the same density as the surrounding material. Piling and butts of utility poles shall be removed to a minimum depth of two feet below the limits of excavation for structures, trenches and roadways or two feet below finish grade, whichever is lower.

3-2.05. Landscaping features shall include, but are not necessarily limited to: fences, cultivated trees, cultivated shrubbery, property corners, man made improvements, subdivision and other signs shall be moved off the easement. The Contractor shall take extreme care in moving landscape features and shall reestablish these features as directed by the Engineer

3-2.06. Surface rocks and boulders shall be grubbed from the soil and removed from the site or used as fill in accordance with Section 02200, Earthwork.

3-2.07. Where the tree limbs interfere with utility wires, or where the trees to be felled are in close proximity to utility wires, the tree shall be taken down in sections to eliminate the possibility of damage to the utility.

3-2.08. Any work pertaining to utility poles shall comply with the requirements of the appropriate utility.

3-2.09. All fences adjoining any excavation or embankment that, in the Contractor's opinion, may be damaged or buried, shall be carefully removed, stored and replaced. Any fencing that is damaged shall be replaced with new fence material of equal or better quality and construction.

3-2.10. Stumps and roots shall be grubbed and removed to a depth not less than two feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to the same density as the surrounding material

3-2.11. Burying of residual materials and organics will not be allowed.

3-2.12. The Contractor shall utilize special precautions required for the protection and preservation of trees, cultivated shrubs, sod, fences, etc. situated within the construction area but not directly within excavation and/or fill limits. The Contractor shall be responsible for repair or replacement of any items damaged as a result of its operations.

3-2.13. Remove lawn sod by cutting into maximum size which can be handled without tearing, stripping sod and underlying topsoil, and stockpiling for use in restoring the surface area. Water sod and otherwise maintain sod in viable, growing condition. Alternative means of lawn sod replacement may be approved by the Engineer.

3-2.14. Remove above-grade structures only where shown on the Drawings or as authorized by the Engineer.

3-3. HOLES AND DEPRESSIONS.

3-3.01. Fill holes, depressions and voids created or exposed by clearing operations with non-organic soil material approved by the Engineer, unless further excavation or earthwork is indicated.

3-3.02. Place fill material in horizontal layers not exceeding six inches loose-depth and compact to a 95 per-cent standard Proctor.

3-4. DISPOSAL OF WASTE MATERIALS.

3-4.01. Disposal General Requirements: Dispose cleared matter daily so as to maintain site in a safe and neat condition throughout the contract period. Owners of the property may remove merchantable timber, buildings or other items from the work site before the Contractor begins operations, and no assurance exists that any such material will be on the work site when the Contractor begins work.

3-4.02. On-Site Disposal: When authorized by the Engineer, cut tree trunks and limbs, over two inches in diameter, into 48-inch lengths and neatly stack within work limits on the same property as that on which the tree originally grew.

On undeveloped property, distribute brush, trees and limbs less than two inches in diameter, within the work area from which cut, as directed by the Engineer. On developed property, remove all such clearing waste and properly dispose of it off-site.

3-4.03. The debris resulting from the clearing and grubbing operation shall be hauled to a disposal site secured by the Contractor and shall be disposed of in accordance with all requirements of federal, state, county and municipal regulations. No debris of any kind shall be deposited in any stream or body of water, or in any street or alley. No debris shall be deposited upon any private property except with written consent of the property owner. In no case shall any material or debris be left on the project site, shoved onto abutting private properties, or buried on the project site.

3-5. CONSTRUCTION ACCESS ROUTE ON EASEMENT.

3-5.01. When shown on the Drawings or directed by the Engineer, a construction access route shall be built on the sewer easement for the purpose of accessing manholes and performing all other necessary work within the easement.

3-5.02. Construction access route shall be cut (10) ten feet wide, minimum, and (6) six inches deep below existing grade. Filter fabric shall be placed at the bottom of the cut, and surge stone shall be placed on top of the fabric, filling the six-inch depth along the roadway.

3-5.03. Surge stone shall be 4” to 6” size (4X6) rip rap type stone, or equivalent. Use sound, tough, durable stones resistant to the action of air and water. Slabby or shaley

pieces will not be acceptable. Specific gravity shall be 2.0 or greater. Stones shall have less than 66 percent wear when tested in accordance with AASHTO T-96.

End of Section

SECTION 02125

TEMPORARY AND PERMANENT EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1-1. SCOPE.

1-1.01. Work under this section includes furnishing all labor, materials, equipment and incidentals required to install and maintain temporary and permanent erosion and sedimentation controls as shown on the Drawings and as specified herein. Work under this Section also includes the subsequent removal of temporary erosion and sedimentation controls at completion of the project.

1-1.02. Temporary and permanent erosion and sedimentation controls include mulching and grassing of disturbed areas and structural barriers at those locations which will ensure that erosion during construction will be maintained within acceptable limits. Acceptable limits are as established by the Georgia Environmental Protection Division (EPD) and applicable codes, ordinances, rules, regulations and laws of local and municipal authorities having jurisdiction.

1-1.03. The temporary and permanent erosion and sedimentation control measures shown on the Drawings are minimum requirements. The Contractor shall notify the Engineer of any changes and/or additions to the erosion and sedimentation control measures necessary to accommodate the Contractor's means and methods of operation. Any additional erosion and sedimentation control measures required by the Contractor's means and methods of operation will be installed by the Contractor at no additional cost to the City.

1-1.04. The Contractor shall be solely responsible for the control of erosion and sediment production within the Project area. The Contractor shall install controls that will ensure that storm water and drainage from the disturbed area of the Project site will be filtered or otherwise managed to minimize impacts on receiving waters and/or existing storm drains. Discharged waters shall be free of soil particles and shall meet all applicable permit turbidity requirements.

1-2. SUBMITTALS.

1-2.01. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

1-3. QUALITY ASSURANCE.

1-3.01. The Contractor shall designate a worksite erosion control supervisor. The supervisor shall have the responsibility and authority to coordinate all equipment, personnel and materials needed to maintain project site erosion and sediment control in accordance with the management practices and standards established in the Manual for Erosion and Sediment Control in Georgia, the Drawings and Specifications.

1-3.02. Within 15 days after receipt of the Notice to Proceed, the Contractor shall submit the name and contact data for the designated erosion control supervisor. The supervisor shall be an individual with an active minimum Level 1 certification as issued by the Georgia Soil and Water Conservation Commission.

PART 2 - PRODUCTS

2-1. MATERIALS.

2-1.01. Silt fence: Silt fence shall be as detailed on the Drawings and shall meet the requirements of Section 171 – Silt Fence of the GDOT Department of Transportation Standard Specifications.

1. Silt fence fabric shall conform to GDOT Standard Specification Section 881.2.07.
2. Silt fencing shall conform to GDOT Standard Specification Section 894.
3. Silt fence posts and bracing shall conform to GDOT Standard Specification Section 862.

2-1.02. Hay bales shall be clean, seed-free cereal hay type, rectangular in shape.

2-1.03. Woven wire fence backing shall be ½-inch, galvanized steel, chicken-wire mesh.

2-1.04. Filter stone shall be crushed rock conforming to Georgia Department of Transportation Table 800.01, Size Number 57.

2-1.05. Concrete block shall be hollow, non load bearing type.

2-1.06. Concrete shall be 3000 psi in accordance with Section 03300, Cast-in-Place Concrete.

2-1.07. Plywood shall be ¾-inch thick exterior type.

2-2. RIP RAP.

2-2.01. Use only one method throughout the Project.

2-2.02. Stone Rip Rap shall consist of sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Specific gravity shall be 2.0 or greater. Rip rap shall have less than 66 percent wear when tested in

accordance with AASHT0 T-96. Unless shown on the Drawings or specified otherwise, stone rip-rap shall be type 3.

Type 1 Rip Rap: The largest pieces shall have a maximum approximate volume of two cubic feet. At least 35 percent of the mass shall be comprised of pieces which weigh 125 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Standard Specification Section 805 - Stone Dumped Rip Rap, Type 1.

Type 3 Rip Rap: The largest pieces shall have a maximum approximate volume of one cubic foot. At least 35 percent of the mass shall be comprised of pieces which weigh 15 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Standard Specification Section 805 - Stone Dumped Rip Rap, Type 3.

2-3. FILTER FABRIC.

2-3.01. Filter fabric for use under rip-rap shall meet the requirements of GDOT Standard Specification Section 881.2.05 for plastic filter fabric.

2-4. CONSTRUCTION EXIT STONE.

2-4.01. Stone shall be sound, tough, durable stone resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Aggregate size shall be in accordance with the National Stone Association Size R-2 (1.5 to 3.5-inch stone) or Type 3 Riprap as specified in paragraph 2.02 of this Section.

2-5. GRASS.

2-5.01. Permanent grass shall be of the same type that existed prior to construction.

2-5.02. Water: Water shall be free of excess and harmful chemicals, organisms and substances which may be harmful to plant growth or obnoxious to traffic. Salt or brackish water shall not be used. Water shall be furnished by the Contractor.

2-6. EROSION CONTROL FABRIC.

2-6.01. Erosion control fabric shall be equal to Futerra Erosion Control Blanket manufactured by Profile Products LLC. Fabric shall be a non-woven erosion control/vegetation blanket comprised of wood fiber and crimped, interlocking synthetic fibers laminated by accelerated photodegradable polypropylene netting. Fabric shall be 100% bio-degradable and photo-degradable within 10 months of installation.

PART 3 - EXECUTION

3-1. GENERAL.

3-1.01. Basic Principles:

1. Conduct the earthwork and excavation activities in such a manner to fit the topography, soil type and condition.
2. Minimize the disturbed area and the duration of exposure to erosion elements.
3. Stabilize disturbed areas immediately.
4. Safely convey run-off from the site to a stable outlet.
5. Retain sediment on site that is generated on site.
6. Minimize encroachment upon watercourses.

3-1.02. Temporary Erosion and Sedimentation Control: Temporary erosion and sedimentation control procedures shall be directed toward:

1. Preventing soil erosion at the source.
2. Preventing silt and sediment from entering any waterway if soil erosion cannot be prevented.
3. Preventing silt and sediment from migrating downstream in the event it cannot be prevented from entering the waterway.

3-1.03. Permanent Erosion Control: Permanent erosion control measures shall be implemented to prevent sedimentation of waterways and to prevent erosion of the Project site.

3-2. SEDIMENTATION AND EROSION CONTROL MEASURES.

3-2.01. Temporary and permanent erosion and sedimentation control measures shall prevent erosion and prevent sediment from exiting the site. If, in the opinion of the Engineer, the Contractor's temporary erosion and sedimentation control measures are inadequate, the Contractor shall provide additional maintenance for existing measures or additional devices to control erosion and sedimentation on the site at no additional cost to the Owner.

3-2.02. All erosion and sedimentation control devices and structures shall be inspected by the Contractor at least once a week and immediately prior to and after each rainfall occurrence. Any device or structure found to be damaged shall be repaired or replaced by the end of the day. Sediment ponds shall be cleaned out prior to the silt reaching the height or elevation shown on the Drawings.

3-2.03. All erosion and sedimentation control measures and devices shall be constructed and installed as shown on the Drawings or specified herein and maintained until adequate permanent disturbed area stabilization has been provided or permanent pavement has been installed and accepted by the Engineer. After adequate permanent

stabilization has been provided or permanent pavement has been installed and accepted by the Engineer, all temporary erosion and sedimentation control structures and devices shall be removed.

3-3. SEDIMENT CONTROL.

3-3.01. Construction Exit: Construction exit(s) shall be placed as shown on the Drawings and as directed by the Engineer. A construction exit shall be located at any point traffic will be leaving a disturbed area to a public right-of-way, street, alley, sidewalk or parking area.

Placement of Construction Exit Material: The ground surface upon which the construction exit material is to be placed shall be prepared to a smooth condition free from obstructions, depressions or debris. The plastic filter fabric shall be placed to provide a minimum number of overlaps and a minimum width of one foot of overlap at each joint. The stone shall be placed with its top elevation conforming to the surrounding roadway elevations. The stone shall be dropped no more than three feet during construction.

Construction Exit Maintenance: The Contractor shall regularly maintain the exit with the top dressing of stone to prevent tracking or flow of soil onto public right-of-way and paved surfaces as directed by the Engineer.

Construction Exit Removal: Construction exit(s) shall be removed and properly disposed of when the disturbed area has been properly stabilized, the tracking or flow of soil onto public right-of-way or paved surfaces has ceased and as directed by the Engineer.

3-3.02. Sediment Barriers: Sediment barriers shall include, but are not necessarily limited to, silt fences, hay bales, rock check dams and inlet sediment traps and any device which prevents sediment from exiting the disturbed area.

Silt fences, hay bales and rock check dams shall not be used in any flowing stream, creek or river.

Sediment barriers shall be installed as shown on the Drawings and as directed by the Engineer.

Sediment barriers shall be maintained to ensure the depth of impounded sediment is no more than one half of the original height of the barrier or as directed by the Engineer. Torn, damaged, destroyed or washed out barriers shall be repaired, reinforced or replaced with new material and installed as shown on the Drawings and as directed by the Engineer.

Sediment Barrier Removal: Sediment barrier shall be removed once the disturbed area has been stabilized with a permanent vegetative cover or permanent pavement has

been installed and the sediment barrier is no longer required as directed by the Engineer.

Accumulated sediment shall be removed from the barrier and removed from the site.

All non biodegradable parts of the barrier shall be disposed of properly. The hay bales may be spread evenly across disturbed areas as a mulching material.

The disturbed area created by barrier removal shall be permanently stabilized.

3-4. EROSION CONTROL.

3-4.01. Grassing: Grassing shall be as specified in paragraph 3-5 of this Section

Temporary Stabilization: Temporary stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Temporary stabilization shall be provided to any area which will not receive permanent stabilization within the next 14 calendar days. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.

Permanent Stabilization: Permanent stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Permanent stabilization shall be provided to all areas of land disturbance within seven calendar days of the completion of land disturbance for any area greater than 0.25 acre. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.

Grass or sod removed or damaged in residential areas shall be replanted with the same variety within seven calendar days of the completion of work in any area.

Where permanent stabilization cannot be immediately established because of an inappropriate season, the Contractor shall provide temporary stabilization. The Contractor shall return to the site at the appropriate season to provide permanent stabilization in areas that received only temporary stabilization.

3-4.02. Erosion Control Blanket: Erosion control blankets shall be applied to sloped areas as indicated on the Drawings and where in excess of 2 to 1 slope. Blankets shall be laid on finished grades that have been seeded, insuring good contact with the soil. Soil surface shall be smooth and free of rocks, roots, debris and other obstructions.

Secure blankets with biodegradable staples or stakes at the top of slopes in a 6-inch deep x 6-inch wide anchoring trench. Secure blankets with staples or stakes per the manufacturer’s recommendations, increasing the spacing at overlapping edges. Blankets shall be overlapped by a minimum of 8-inches. Provide a 6-inch deep x 6-inch wide anchoring trench at the toe of the slope or shoreline.

3-5. GRASSING.

3-5.01. General:

1. Refer to Section 02933, Seeding for detailed specifications on permanent seeding.
2. When final grade has been established, all bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched in an effort to restore to a protected condition.
3. Specified permanent grassing shall be performed at the first appropriate season following establishment of final grading in each section of the site.
4. All references to grassing, unless noted otherwise, shall relate to establishing permanent vegetative cover as specified herein for seeding, fertilizing, mulching, etc.
5. Permanent grassing shall be of a perennial species.

3-5.02. Grassing activities shall comply with Section 02933, Seeding and the Manual for Erosion and Sediment Control in Georgia, specifically for the selection of species, planting dates and application rates for seeding, fertilizer and mulching. Where permanent vegetative cover (grassing) cannot be immediately established (due to season or other circumstances) the Contractor shall provide temporary vegetative or mulch cover.

3-6. RIP-RAP.

3-6.01. Unless shown otherwise on the Drawings, rip-rap shall be placed at all points where banks of streams or drainage ditches are disturbed by excavation, or at all points where their natural vegetation is removed. Carefully compact backfill and place rip rap to prevent subsequent settlement and erosion. This requirement applies equally to construction alongside a stream or drainage ditch as well as crossing a stream or drainage ditch.

3-6.02. When trenching across a creek, place rip-rap a distance of 10 feet upstream and 10 feet downstream from the top of the trench excavation. Place rip rap across creek bottom, across creek banks and extend rip-rap placement five feet beyond the top of each creek bank.

3-6.03. Preparation of Foundations: The ground surface upon which the rip rap is to be placed shall be brought in close conformity to the correct lines and grades before placement is commenced. Where filling of depressions is required, the new material shall be compacted with hand or mechanical tampers.

Unless at creek banks or otherwise shown or specified, rip-rap shall begin in a toe ditch constructed in original ground around the toe of the fill or the cut slope. The toe ditch shall be two feet deep in original ground, and the side next to the fill or cut shall have that same slope. After the rip-rap is placed, the toe ditch shall be backfilled.

3-6.04. Placement of Filter Fabric: The surface to receive fabric shall be prepared to a relatively smooth condition free from obstructions, depressions and debris. The fabric shall be placed with the long dimension running up the slope and shall be placed to provide a minimum number of overlaps. The strips shall be placed to provide a minimum width of one foot of overlap for each joint. The filter fabric shall be anchored in place with securing pins of the type recommended by the fabric manufacturer. Pins shall be placed on or within 3-inches of the centerline of the overlap. The fabric shall be placed so that the upstream strip overlaps the downstream strip. The fabric shall be placed loosely so as to give and therefore avoid stretching and tearing during placement of the stones.

The fabric shall be protected at all times during construction from clogging due to clay, silts, chemicals or other contaminants. Any contaminated fabric or any fabric damaged during its installation or during placement of rip-rap shall be removed and replaced with uncontaminated and undamaged fabric at no expense to the City.

3-6.05. Placement of Rip-Rap: The rip-rap shall be placed on a 6-inch layer of soil, crushed stone or sand overlaying the filter fabric. This 6-inch layer shall be placed to maximize the contact between the soil beneath the filter fabric and the filter fabric. Rip-rap shall be placed with its top elevation conforming to the finished grades or the natural slope of the stream bank and stream bottom.

The stones shall be dropped no more than 3 feet during construction.
Stone rip-rap shall be dumped into place to form a uniform surface and to the thickness specified on the Drawings. The thickness tolerance for the course shall be -6-inches and +12-inches. If the Drawings do not specify a thickness, the course shall be placed to a thickness of not less than 18-inches.

3-7. CLEAN-UP.

3-7.01. Remove and dispose of all excess erosion and sedimentation control devices and materials when no longer needed or at the completion of construction as directed by the Engineer.

End of Section

SECTION 02140

DEWATERING

PART 1 - GENERAL

1-1. SCOPE.

Construct all permanent Work in areas free from water. Design, construct and maintain all dikes, levees, cofferdams and diversion and drainage channels as necessary to maintain the areas free from water and to protect the areas to be occupied by permanent work from water damage. Remove temporary works after they have served their purpose.

The Contractor shall be responsible for the stability of all temporary and permanent slopes, grades, foundations, materials and structures during the course of the Contract. Repair and replace all slopes, grades, foundations, materials and structures damaged by water, both surface and sub-surface, to the lines, grades and conditions existing prior to the damage at no additional cost to the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3-1. CARE OF WATER.

Except where the excavated materials are designated as materials for permanent work, material from required excavation may be used for dikes, levees, cofferdams and other temporary backfill.

Furnish, install, maintain and operate necessary pumping and other equipment for dewatering the various parts of the Work and for maintaining the foundation and other parts free from water as required for constructing each part of the Work.

Install all drainage ditches, sumps and pumps to control excessive seepage on excavated slopes, to drain isolated zones with perched water tables, and to drain impervious surfaces at final excavation elevation.

After they have served their purpose, remove all temporary protective work at a satisfactory time and in a satisfactory manner. All diversion channels and other temporary excavations in areas where the compacted fill or other structures will be constructed shall be cleaned out, backfilled and processed under the same Specifications as those governing the compacted fill.

When the temporary works will not adversely affect any item of permanent work or the planned usage of the Project, the Contractor may be permitted to leave such temporary works in place. In such instances, breeching of dikes, levees and cofferdams may be required.

3-2. DEWATERING.

By the use of well points, pumps, tile drains or other approved methods, the Contractor shall prevent the accumulation of water in excavated areas. Should water accumulate, it shall be promptly removed.

Excavations shall be continuously dewatered to maintain a ground water level no higher than 2 feet below the lowest point in the excavation.

Piezometric observation wells shall be required, to monitor the ground water level, to insure proper dewatering prior to excavation below the static water table. The number of wells required will vary depending on the size and depth of structures.

No separate payment will be made for dewatering required to accomplish the work.

Baseplates shall be set level in exact position and grouted in place.

End of Section

Section 02200

EXCAVATION AND FILL FOR STRUCTURES

PART 1 - GENERAL

1-1. SCOPE. This section covers earthwork and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation; handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of sub-grades; pumping and dewatering as necessary; protection of adjacent property; backfilling; construction of fills and embankments; grading; and other appurtenant work.

1-2. GENERAL. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed or registered professional engineer in the state where the earthwork is located, to act upon all pertinent matters of the work of this section.

1-3. SUBMITTALS. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittals Procedures section.

At least 30 days before starting construction on the sheeting and shoring and in accordance with OSHA requirements enumerated above, the Contractor shall ensure that the sheeting and shoring design engineer shall complete and submit to Engineer the Protection System Design Certificate (Figure 1-02200) and the Contractor shall use the sheeting and shoring design. If required by the OSHA requirements enumerated above or to protect existing facilities, then the Contractor is responsible for ensuring that a separate certificate shall be submitted for each unique design. If required for protection of existing facilities or as required by the enumerated OSHA regulations, the certificate shall be signed and sealed by the registered professional engineer that designed the protection system.

1-3.01. Filter Fabric Data. Complete descriptive and engineering data for the fabric shall be submitted in accordance with the Submittals Procedures section. Data submitted shall include:

A 12 inch 300 mm square sample of fabric.

Manufacturer's descriptive product data.

Installation instructions.

1-3.02 Test Results for Preliminary Review of Materials. Complete test results by an independent commercial laboratory retained by the Contractor for preliminary review of materials proposed for use in fills and embankments, structure backfill, select fill, granular fill, gravel beneath slabs, and any other fill material specified herein.

1-3.03 CLSM Mix Design. Mix design by in independent commercial laboratory to be retained by the Contractor.

1-4. BASIS FOR PAYMENT.

1-4.01. Sheeting for Excavation of Structures. No additional payment above the Contract Price will be made for steel sheet piling left in place in excavations for structures.

1-5. INSURANCE. Professional Liability insurance shall be provided as specified in the Supplementary Conditions.

PART 2 - PRODUCTS

2-1. MATERIALS.

2-1.01. Filter Fabric. Filter fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris.

2-1.01.01. Filter Fabric Type A. Filter fabric Type A shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter fabric Type A shall be a non-woven fabric consisting of only continuous chains of polypropylene filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties:

Property	Test Method	Unit	Min Roll Value*
Fabric Weight	ASTM D3776	oz/yd^2 g/m^2	6.0 203
Grab Strength	ASTM D4632	lbs N	160 711
Grab Elongation	ASTM D4632	percent	50
CBR Puncture Strength	ASTM D6241	lbs N	410 1,824
Trapezoidal Tear	ASTM D4533	lbs N	60 267
UV Resistance at 500 hours	ASTM D4355	% Strength Retained	70

*Minimum average roll value in weakest principal direction.

The apparent opening size (diameter) for the filter fabric Type A shall be no larger than the U.S. Standard Sieve Size 70 212 µm per ASTM D4751.

2-1.01.02. Filter Fabric Type B. Filter fabric Type B shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter fabric Type B shall be a non-woven fabric consisting of only continuous chains of polypropylene filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents, and shall have the indicated properties:

Property	Test Method	Unit	Min Roll Value*
Fabric Weight	ASTM D3776	oz/yd^2 g/m^2	10 339
Grab Strength	ASTM D4632	lbs N	270 1,201
Grab Elongation	ASTM D4632	Percent	50
CBR Puncture Strength	ASTM D6241	lbs N	700 3,115
Trapezoidal Tear	ASTM D4533	lbs N	100 444
UV Resistance at 500 hours	ASTM D4355	% Strength Retained	70

*Minimum average roll value in weakest principal direction.

The apparent opening size (diameter) for the filter fabric Type B shall be no larger than the U.S. Standard Sieve Size 70 212 µm per ASTM D4751.

2-1.01.03. Filter Fabric Type C. Filter fabric Type C shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter fabric Type C shall be a woven monofilament fabric consisting of polypropylene. Filter fabric Type C shall have the indicated properties:

Property	Test Method	Unit	Minimum Average* Roll Value
Fabric Weight	ASTM D3776	oz/yd^2 g/m^2	6.0 200
Grab Strength	ASTM D4632	lbs N	300 1,300
Elongation at Break	ASTM D4632	percent	12
CBR Puncture Strength	ASTM D6241	lbs N	900 4,005
Trapezoidal Tear	ASTM D4533	lbs N	110 490

Property	Test Method	Unit	Minimum Average* Roll Value
UV Resistance at 500 hours	ASTM D4355	% Strength Retained	70

*Minimum average roll value in weakest principal direction.

The apparent opening size (diameter) for the filter fabric Type C shall be no larger than the U.S. Standard Sieve Size 70 212 µm per ASTM D4751.

2-1.02. Polyethylene Film. Polyethylene film beneath concrete slabs or slab base course material shall be Product Standard PS17, 6 mil minimum thickness.

2-1.03. General Fill and Embankment Materials. To the maximum extent available, excess suitable material obtained from structure and trench excavation shall be used for the construction of general fills and embankments. Additional material shall be provided from Contractor's off-site source. No borrow pits shall be opened on site unless such pits are specifically indicated on the Drawings.

All material placed in fills and embankments shall be free from rocks or stones larger than the required size in their greatest dimension, brush, stumps, logs, roots, debris, and other organic or deleterious materials. The maximum size of stone in fills and embankment shall be 4 inches. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so that they do not interfere with proper compaction.

2-1.04. Granular Fill. Granular fill material shall be crushed rock or gravel suitable for use as a free draining sub-base beneath slabs and foundations. Granular fill shall be free from dust, clay, and trash; hard, durable, non-friable; and shall be graded 3/4 inch to No. 4 19 to 4.75 mm as defined in ASTM C33 for No. 67 coarse aggregate. Granular fill shall meet the quality requirements for ASTM C33 coarse aggregate. Only crushed rock with angular particles shall be used when the perimeter of the granular fill is not confined or otherwise subject to raveling, such as on a slope.

2-1.05. Structure Backfill. Structure backfill shall be defined as the material placed around and outside of structures. For structures constructed in open excavations, structure backfill shall extend to the temporary excavation slope so that the entire excavation outside the structure shall be filled with structure backfill. For structures constructed in supported excavations, the structure backfill shall completely fill the space between structure and excavation support system, or between structure and excavation face, if these specifications permit removal of the excavation support system. Structure backfill shall be as indicated herein.

2-1.05.01. General Fill Structure Backfill. General fill for structure backfill shall meet the requirements of the previous paragraph entitled "General Fill and Embankment Materials".

2-1.05.02. Crushed Rock Structure Backfill. Crushed rock for structure backfill shall meet the following gradation requirements:

Size	Percent Passing
1/2 inch 12.5 mm	100
3/8 inch 9.5 mm	90 – 100
No. 4 4.75 mm	30 – 60
No. 8 2.36 mm	0 – 10
No. 200 75 µm	0 - 5

2-1.05.03. Clean Sand Structure Backfill. Clean sand for structure backfill shall meet the following gradation requirements:

Size	Percent Passing
3/8 inch 9.5 mm	100
No. 4 4.75 mm	95 – 100
No. 8 2.36 mm	75 – 90
No. 30 600 µm	30 – 50
No. 100 150 µm	2 – 10
No. 200 75 µm	0 - 5

2-1.06. Select Fill. Select fill shall be defined as the material placed beneath the structure foundations and slabs below any granular material layer or lean concrete slab indicated on the Drawings. Select fill shall be used to replace any unsuitable material below the structure foundations and slabs and to raise the site grades below and within 5 feet (unless a larger dimension is otherwise indicated on the Drawings or specified) of structural footprints and at locations indicated on the Drawings. Select fill shall be as indicated herein.

2-1.06.01. General Fill Select Fill. General fill for use as select fill shall meet the requirements of the previous paragraph entitled “General Fill and Embankment Materials”.

2-1.06.02. Crushed Rock Select Fill. Crushed rock for select fill shall meet the following gradation requirements:

Size	Percent Passing

Size	Percent Passing
1/2 inch 12.5 mm	100
3/8 inch 9.5 mm	90 – 100
No. 4 4.75 mm	30 - 60
No. 8 2.36 mm	0 - 10
No. 200 75 µm	0 - 5

2-1.06.03. Clean Sand Select Fill. Clean sand for select fill shall meet the following gradation requirements:

Size	Percent Passing
3/8 inch 9.5 mm	100
No. 4 4.75 mm	95 – 100
No. 8 2.36 mm	75 – 90
No. 30 600 µm	30 – 50
No. 100 150 µm	2 – 10
No. 200 75 µm	0 - 5

2-1.07. Gravel Base Beneath Slabs. "Gravel Base Beneath Slabs" is defined as material to be placed directly beneath floor slabs of building as shown on the Drawings. The material shall meet the quality requirements specified for ASTM C33 concrete coarse aggregate and shall be graded No. 7 coarse aggregate.

2-1.08. Controlled Low Strength Material (CLSM).
CLSM shall consist of a mixture of Portland cement, fly ash, sand, and water and shall be placed at locations indicated on the Drawings or as directed by Engineer. The class of CLSM shall be as specified below.

The type of cement in CLSM shall be ASTM C150 Type I.. The class of fly ash in CLSM shall be ASTM C618 Class C, except loss on ignition shall not exceed 4 percent. Fine aggregate in CLSM shall be clean natural sand, ASTM C33, except that clay particles shall not exceed one percent. Water in CLSM shall be potable.

Contractor shall design and test the CLSM. Contractor shall submit the mix design and test results to Engineer for review and acceptance. The mix design shall be such as to ensure that the CLSM hardens sufficiently to support the weight of an average person in one to four hours after placement and support equipment weight in 24 hours. CLSM shall be self-leveling and shall have an efflux time of 10 to 26 seconds through a special flow cone with a 1/2 inch 12.7 mm discharge tube. Penetration resistance shall be determined in accordance with ASTM C403 for at least 1,000 minutes after adding

water and a graph prepared and submitted for penetration resistance vs. time from adding water to the mixture.

The batch proportions accepted by Engineer apply only for materials from the same source and having the same characteristics as the materials used in the mix design. Materials from any other source shall be used only with the acceptance of Engineer.

If a change in sources of materials is proposed, a new mix design shall be developed by Contractor before the new material is used. When unsatisfactory results or other conditions make it necessary, Contractor shall develop a new mix design to get the desired results.

During the progress of the work, no change shall be made in the batch proportions of the ingredients without the acceptance of Engineer.

2-1.08.01. Class A CLSM. The initial trial mixture for Class A CLSM shall consist of the following minimum proportions per cubic yard to provide minimum compressive strength listed below:

Cement	50 lbs 23 kg
Fly Ash	250 lbs 113 kg
Sand (SSD)	2860 lbs 1297 kg
Water	370 lbs 168 kg
Air Entraining admixture	6 percent
Minimum compressive strength at 28 days	129 psi 889 kPa

2-1.08.02. Class B CLSM. The initial trial mixture for Class B CLSM shall consist of the following minimum proportions per cubic yard to provide minimum compressive strength listed below:

Cement	100 lbs 45 kg
Fly Ash	100 lbs 45 kg
Sand (SSD)	2760 lbs 1252 kg
Water	386 lbs 175 kg
Air Entraining admixture	5 percent
Minimum compressive strength at 28 days	202 psi 1.4 MPa

2-1.08.03. Class C CLSM. The initial trial mixture for Class C CLSM shall consist of the following minimum proportions per cubic yard to provide minimum compressive strength listed below:

Cement	80 lbs 36 kg
Fly Ash	275 lbs 125 kg
Sand (SSD)	2795 lbs 1268 kg
Water	370 lbs 122 kg
Air Entraining Agent	4 percent
Minimum compressive strength at 28 days	370 psi 2.5 MPa

2-1.09. Geocomposite Sheet Drains. The geocomposite sheet drains shall consist of a continuous plastic three dimensional drainage core wrapped on one side in a non-woven filter fabric permeable to water flow. The filter fabric shall be bonded to the individual dimples of the molded plastic core to minimize fabric intrusion into the flow channels caused by the backfill pressure. The fabric shall extend beyond the edges of the core to provide overlap for the adjacent panels. The geocomposite sheet drain shall be Miradrain 6000 as manufactured by Mirafi, Inc., or Ameridrain 200 as manufactured by American Wick Drain Corporation, or equal.

2-2. MATERIAL TESTING.

2-2.01. Preliminary Review of Materials. As stipulated in the Quality Control section, all tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of Contractor. Two initial gradation tests shall be made for each type of general fill, select fill, structure backfill, granular fill, or other specified material, and one additional gradation test shall be made for each additional 500 tons 450 Mg of each material delivered (imported) to the jobsite or suitable onsite material incorporated in select fill or structure backfill. One additional gradation test shall be performed for each additional 2,000 tons of general fill material delivered to the jobsite or suitable onsite material incorporated in general fill. In addition, one set of initial Atterberg Limits test shall be made for each fill material containing more than 20 percent by weight pass the No. 200 sieve and for materials specified by Atterberg Limits. One additional Atterberg Limits test shall be made for each additional 500 tons 450 Mg of each material delivered to the job site or otherwise incorporated in select fill or structure backfill. One additional Atterberg Limits test shall be made for each additional 2,000 tons of general fill material delivered to the jobsite or suitable onsite material incorporated in general fill.
All material testing on CLSM shall be made by an independent testing laboratory at the expense of Contractor.

2-2.02. Field Testing Expense. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory at the expense of Owner. Contractor. Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.

2-2.03. Required Field Tests. For planning purposes the following guidelines shall be used for frequency of field tests. Additional tests shall be performed as necessary for job conditions and number of failed tests. Test results shall be submitted as indicated in the Submittals Procedures section.

Two moisture-density (Proctor) tests in accordance with ASTM D698 (or, when required, ASTM D1557), or two relative density tests in accordance with ASTM D4253 and D4254 for each type of general fill, select fill, structure backfill, granular fill, or other material proposed.

For area fills and embankments, an in-place field density and moisture test for each 1000 cubic yards 764 m^3 of material placed.

One in-place field density and moisture test for every 100 to 200 cubic yards 76 to 153 m^3 of structure backfill or select fill.

One in-place density and moisture test whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.

At least one test for every full shift of compaction operations on mass earthwork.

Additional gradation, proctor, and relative density tests whenever the source or quality of materials changes.

Testing of CLSM shall be as follows.

Compressive Strength. For every 200 cubic yard 153 m^3 of flowable fill placed, fill four 6 by 12 inch 150 by 300 mm plastic cylinder molds to overflowing and then tap sides lightly. Cure cylinders in the molds covered until time of testing, at least 14 days. Strip the cylinders carefully using a knife to cut away the plastic mold. Cap the cylinders with high strength gypsum plaster or other capping process that will not break these low strength materials. Test cylinders in accordance with ASTM C39. Two cylinders shall be tested at 7 days and the other two cylinders shall be tested at 28 days.

Flow of Fill. Once each day that flowable fill is placed, test the fill material in accordance with ASTM C939 for the efflux time. Wet screening may be required to remove coarse particles.

Unit Weight and Yield. Once each day that flowable fill is placed, determine unit weight and yield in accordance with ASTM C138.

Air Content. Once each day that flowable fill is placed, determine air content in accordance with ASTM C231.

PART 3 - EXECUTION

3-1. SITE PREPARATION. All sites to be occupied by permanent construction or embankments shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for fills and embankments and sites to be occupied by permanent construction shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. All waste materials shall be removed from the site and disposed of by and at the expense of Contractor.

3-2. EXCAVATION.

3-2.01. General. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Sub-grade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Excavations for manholes and similar structures constructed of masonry units shall have such horizontal dimensions that not less than 6 inches 150 mm clearance is provided for outside plastering.

3-2.02. Classification of Excavated Materials Classification of excavated materials shall be made as follows:

Rock. Rock is defined as being sandstone, limestone, flint, granite, quartzite, slate, hard shale, or similar material in masses more than 1 cubic yard 1 m^3 in volume or in ledges 4 inches 100 mm or more in thickness.

Should rock be encountered in two or more ledges, each ledge being not less than 3 inches 75 mm thick and with interlying strata of earth, clay, or gravel not more than 12 inches 300 mm thick in each stratum, the entire volume between the top of the top ledge and the bottom of the bottom ledge will be classified as rock.

Earth. All material not classified as rock.

3-2.03. Preservation of Trees. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from damage by construction operations.

3-2.04. Unauthorized Excavation. Except where otherwise authorized, indicated, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced with concrete or lean concrete at the expense of Contractor. If structural concrete replacement is chosen, it shall be with concrete placed at the same time and monolithic with the concrete foundation.

3-2.05. Blasting. Blasting or other use of explosives for excavation will not be permitted. Blasting shall be performed in accordance with all laws, regulations, and ordinances in effect at the time of blasting and required by the authority having jurisdiction thereover. Contractor shall engage the services of a qualified blasting engineer to develop blasting procedures and assist in monitoring blasting operations.

Contractor shall notify all affected adjacent property occupants at least 24 hours prior to any blasting. Contractor shall be responsible for all damage caused by blasting operations and shall be responsible for responding to and resolving all complaints. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench.

All rock which cannot be handled, crushed, processed, and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed.

Blasting or other use of explosives for excavation adjacent to existing utilities, structures, and other facilities shall be in conformity with the requirements of the local ordinance and the authority having jurisdiction thereover and shall not cause damage to any adjacent structures. Contractor shall consult with and obtain written approval for blasting procedures from the appropriate utility or agency before blasting adjacent to their utilities, structures, or other facilities. Certain utilities, including gas pipelines and fiber optics, and agencies have requirements that will not permit blasting adjacent to or within a minimum distance from their utilities or structures, including utilities and structures outside the construction easements or on the opposite side of the street, if applicable. The blasting procedures shall be in conformity with the requirements of the utility, if applicable. Contractor shall submit to Owner a copy for the record of the blasting procedures signed and sealed by the blasting engineer.

Contractor shall be responsible for obtaining all required blasting permits from the city, county, state and federal agencies and shall provide sufficient prior notice as specified by code, ordinance or other regulation to the county engineer, county sheriff, fire districts, police departments, and all other appropriate agencies and authorities where the blasting is to be performed. A copy of the blasting permit shall be on the site before and during the blasting operations. Owner shall be furnished a copy of all blasting permits at least 7 days prior to blasting.

3-2.05.01. Pre-blast Survey. Contractor shall perform a pre-blast survey of all utilities, structures, and other facilities adjacent to the blast sites to determine the conditions of each utility, house, building, bridge, overpass, and other structures and facilities susceptible to damage from blasting operations. The pre-blast survey shall include all structures and utilities within a minimum of 500 feet 152 m radius of the area to be blasted. The survey notification to all property owners, tenants, utilities, and other agencies and the area of survey shall be in conformity with the requirements of the authority having jurisdiction thereover or as determined by Contractor's insurance

company if no local ordinance applies. Contractor shall submit the pre-blast survey report for record purposes, to Owner.

3-2.05.02. Blast Monitoring. Prior to the start of Contractor's blasting, Contractor shall measure background ground vibrations.

Seismographs shall be placed on the ground adjacent to structures subjected to ground shock to measure peak particle velocity components in three mutually perpendicular directions during blasting operations.

The peak particle velocity, defined as the maximum of the three velocity components of vibration, at any location shall not exceed values that will cause damage to the adjacent structures. Air overpressure shall be measured at adjacent structures. Air overpressure at adjacent structures shall not exceed values that will cause damage to the adjacent structures or personnel. The maximum peak particle velocity and air overpressure values that will not cause damage shall be determined by the blasting engineer retained by Contractor and shall be stated in the blasting procedures.

Contractor shall submit measurement records of the blast monitoring within 24 hours after each blast for record purposes to Owner.

3-2.05.03. Post-blast Survey. Contractor shall perform a post-blast survey of the same utilities, structures, and other facilities surveyed in the pre-blast survey to determine the effect of the blasting operations. Contractor shall submit the post-blast survey report for record purposes to Owner.

3-2.06. Dewatering. Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater and all water, regardless of the source, entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of 12 inches 300 mm, beneath such excavations. The specified dewatering depth shall be maintained below the prevailing bottom of excavation at all times.

Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.

Contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

3-2.07. Sheeting and Shoring. Except where banks are cut back on a stable slope, excavations for structures and trenches shall be supported as necessary to prevent caving or sliding.

Steel sheet piling or other excavation support systems shall be furnished and installed as necessary to limit the extent of excavations for the deeper structures and necessary backfill under adjacent shallower structures, and to protect adjacent structures and facilities from damage due to excavation and subsequent construction. Contractor shall assume complete responsibility for, and install adequate protection systems for prevention of damage to existing facilities.

Excavation support systems and sheeting and shoring shall be all removed after completion of work.shall be removed unless specifically otherwise permitted by Engineer.shall be removed or left in place at Contractor's discretion.

Unless the excavation support is required to be left in place the design of the excavation support system shall be such as to permit complete removal while maintaining safety and stability in the excavation at all times. Excavation support systems to be left in place shall be designed and constructed of only steel and pressure treated timber elements. Untreated timber shall not be used.

Sheeting, shoring and excavation support systems shall be designed by a professional engineer registered in the state where the project is located.

3-2.08. Stabilization. Sub-grades for concrete structures shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.

Sub-grades for concrete structures which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel as specified for granular fills. The stabilizing material shall be placed in such a manner that no voids remain in the granular fill. All excess granular fill with unfilled void space shall be removed. The finished elevation of stabilized sub-grades shall not be above sub-grade elevations indicated on the Drawings.

3-2.09. Ring-wall Excavation. All surface vegetation, sod, and organic topsoil shall be removed beneath and within ring-wall foundations.

3-2.10. Roadway Excavation. Excavation for the roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the Drawings and shall include the excavation of all unsuitable material from the subgrade. After shaping to line, grade, and cross section, the subgrade shall be compacted to a depth of at least 6 inches 150 mm and shall meet the following:

Test method to determine maximum density and moisture.	ASTM D698.ASTM D1557.
Relative compaction and moisture content relative to the optimum.	95%.
Moisture content relative to the optimum.	-2% to +2%.

This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material.

3-3. GENERAL FILLS AND EMBANKMENTS. Fills and embankments not required or indicated to be designated fills shall be constructed as general fills and embankments. All fills and embankments shall be constructed to the lines and grades indicated on the Drawings. Construction of fills and embankments shall begin from the lowest elevation in a given excavation or area and progress upward. Materials shall be deposited in approximately horizontal layers not to exceed 8 inches 200 mm in uncompacted thickness. Unless otherwise specified herein, the following governing standards apply:

Test method to determine maximum density and moisture.	ASTM D698.ASTM D1557.
Relative compaction.	98 %.
Moisture content relative to the optimum.	-2% to +2%.

Backfilling of excavations and construction of fills and embankments during freezing weather shall not be done. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

3-3.01. Sub-grade Preparation. After preparation of the fill or embankment site, the sub-grade shall be scarified and moisture conditioned to a minimum depth of 6 inches 150 mm, leveled and rolled so that surface materials of the sub-grade will be at a moisture content and as compact and well bonded with the first layer of the fill or embankment as specified for subsequent layers.

Unless otherwise directed by Engineer, the sub-grade shall be proof-rolled by a rubber-tired roller, a loaded dump truck, or other suitable rubber-tired equipment acceptable to Engineer. A minimum of four passes of the proof-rolling equipment shall be provided such that the last two passes are made perpendicular to the first two passes.

All soft, yielding, or otherwise unsuitable material shall be removed and replaced with compacted fill.

3-3.02. Placement and Compaction. All fill and embankment materials shall be placed in approximately horizontal layers not to exceed 8 inches 200 mm in un-compacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried to achieve the moisture content relative to optimum as specified above, and shall be thoroughly mixed to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to the required degree of compaction at the required moisture content. If the material fails to meet the density specified, compaction methods shall be altered. The changes in compaction methods shall include, but not be limited to, changes in compaction equipment, reduction in uncompacted lift thickness, increase in number of passes, and better moisture control.

Wherever a pipe is to installed within a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than 12 inches 300 mm above the top of pipe elevation before the trench for pipe installation is excavated.

Fills and embankments over reservoir or basin roof slabs shall be placed and compacted by using methods that will not damage or overload the structure; compaction in addition to that attained by placement operations will not be required. Rubber-tired equipment shall be used insofar as possible. Individual items of equipment operated on reservoir or basin roof slabs shall not have loaded weight in excess of 14,000 lbs 62 kN and shall be so operated that no impact loads are imposed on the structure. Fill material shall not be piled on the roof slab to a depth greater than 12 inches 300 mm above finished grade elevation. Fill construction shall begin at the walls, and construction equipment shall operate on a layer of fill material at least 12 inches 300 mm deep. Special care shall be taken to avoid damaging or disturbing any roofing membrane, tile drains, or granular fill material.

3-3.03. Borrow Pits. Suitable material necessary to complete fills and embankments may be excavated from borrow pits indicated on the Drawings and hauled to the site of the work. The size, shape, depth, drainage, and surfacing of all borrow pits shall be acceptable to Engineer. Borrow pits shall be regular in shape, with graded and surfaced side and bottom slopes, when completed. Side slopes of borrow pits shall be not steeper than 3 horizontal to 1 vertical and shall be uniform for the entire length of any one side.

3-4. DESIGNATED FILLS. Designated fills are all fills designated by a name and included as subparagraph under this heading. Fills required or indicated to be designated fills shall be constructed using the specific materials and placement requirements as specified. In addition to the specific requirements specified herein, all requirements for general fills and embankments shall apply. These requirements

include, but are not limited to organic or deleterious materials, subgrade preparation, lift thickness, and moisture conditioning requirements. All designated fills shall be constructed to the lines and grades indicated on the Drawings. Backfilling and construction of fills during freezing weather shall not be done except by permission of Engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

3-4.01. Granular Fill. Granular fills shall be provided where indicated on the Drawings. Granular fills shall be placed on suitably prepared sub-grades in uncompacted lift thickness of 6 inches 150 mm or less and compacted by vibration. Granular fills shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254. If the thickness of the granular fill is less than 6 inches, the compaction shall be by a minimum four passes (round trips) of a self-propelled or walk-behind type vibratory roller operating in full vibration mode in accordance with manufacturer's instructions.

Where granular fills are to be covered with concrete, the top surface shall be graded to the required sub-grade elevation. The completed fill shall be covered by a vapor barrier.

3-4.02. Structure Backfill. Backfill materials shall be deposited in approximately horizontal layers not to exceed 8 inches 200 mm in uncompacted thickness and shall meet the following requirements:

Test method to determine maximum density and moisture.	ASTM D698.ASTM D1557.
Relative compaction.	98%.
Moisture content relative to the optimum.	-2% to +2%

Compaction of structure backfill shall be performed in such a manner that damage to the structure is prevented. The compaction equipment used within 8 feet 2.4 m of the walls and for the top 8 feet 2.4 m of backfill shall be the static typebe the vibrating type. Limit of equipment weight shall be 1 ton 907 kg. 2 ton 1,814 kg. Compaction of structure backfill by inundation with water will not be permitted.

No backfill shall be deposited or compacted in water.

Particular care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a pipe is to be installed within structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches 300 mm above the top of pipe before the trench for pipe installation is excavated.

Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

3-4.03 Select Fill. Select fill shall be placed in approximately horizontal layers in uncompacted lift thickness of 8 inches or less and shall meet the following requirements:

Test method to determine maximum density and moisture.	ASTM D698.ASTM D1557.
Relative compaction.	98 %.
Moisture content relative to the optimum.	-2% to +2%.

3-4.04. Gravel Base Beneath Slabs. The gravel base beneath slabs shall be placed in uncompacted lift thickness of 6 inches 150 mm or less and compacted with a minimum of four passes (round trips) of a self-propelled or walk-behind type vibrating roller. The roller shall be operated in the full vibrating mode and in accordance with the manufacturer's instructions.

3-4.05. Controlled Low Strength Material (CLSM) Fill. CLSM shall not be placed on frozen ground. Batching, mixing, and placing of CLSM may be started when weather conditions are favorable and when the temperature is at least 34°F 1.1°C and rising. At time of placement of CLSM the temperature shall be at least 40°F 4.4°C. Mixing and placing shall stop when the temperature is 38°F 3.3°C and falling. Each filling stage shall be as continuous an operation as is practicable.

CLSM shall be discharged from the mixer by an acceptable procedure into the area to be filled. CLSM shall be placed to limits indicated on the Drawings. Mixing CLSM with in-situ soil shall be avoided.

When CLSM is placed as backfill against structures, the fill shall be placed in lifts of 2 to 3 feet 0.6 to 1 meter and the next lift shall not be placed until the previous lift can support the weight of workers without indenting the surface and at least 16 hours have elapsed from the end of placement. Lift thickness shall be reduced as necessary to prevent floatation of the structure.

When CLSM is placed over culverts or pipelines, they shall be anchored to prevent flotation during the placement of CLSM. Unless otherwise required, CLSM shall be placed to one foot below the finished grade elevation if the finished grade elevation is not more than 5 feet 1.5 meters over the top of the culvert or pipe. If the finished grade is more than 5 feet 1.5 meters over the top of the culvert or pipe, CLSM shall be placed to an elevation 2 feet 0.6 meters over the top of the culvert or pipe, and the remainder shall be backfilled with the specified backfill or as indicated on the Drawings.

3-4.06. Ringwall Fill. Fill within ringwall foundations shall be granular fill and shall be placed and compacted as indicated on the Drawings and as specified herein. If no treated sand layer is required directly beneath the tank bottom, the fill shall be sloped or crowned up to the center of the tank or reservoir as indicated on the Drawings. If a treated sand layer is required, the fill shall be finished to true grade in preparation for the treated sand layer.

3-5. FILTER FABRIC INSTALLATION. Filter fabric shall be placed as specified herein and at the locations specified or otherwise indicated on the Drawings.

Filter fabric shall be protected at all times during construction from contamination by foreign material and damage. Any contaminated or damaged filter fabric shall be replaced with new filter fabric at no additional cost to the Owner. The work shall be scheduled so that covering of the filter fabric is accomplished within 7 calendar days after placement of the filter fabric.

The subgrade for placement of filter fabric shall be smooth and free of irregularities and undulations. Filter fabric shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. Type A and B filter fabric shall be overlapped a minimum of 2 feet between adjacent roll ends and adjacent strips.

The joints of Type C filter fabric shall be sewn. All seams shall be formed by mating the edges of the filter fabric panels and sewing them together with continuous stitches located a minimum of three inches from the edges. The thread shall be ultraviolet light resistant and manufactured from the same material as the filter fabric. A two-thread, type 401 double-lock stitch shall be used for all sewn work. Sewing methods shall conform to the latest procedures recommended by the filter fabric manufacturer. The Contractor shall demonstrate that the seam efficiency meets the requirements of the specified tabulated properties for the filter fabric as applicable.

All filter fabric placed shall be fixed to the subgrade to prevent filter fabric slippage or movement during placement of subsequent materials. Pins or staples shall not be used to fix the filter fabric to the subgrade when a geomembrane is to be placed on top of the filter fabric.

The Contractor shall exercise extreme care during filter fabric installation to prevent damage to the prepared supporting subgrade surface. The Contractor shall exercise care to prevent the entrapment of rocks, clods of earth or other material which could damage the filter fabric, clog the filter fabric or hamper seaming. Any filter fabric surface showing damage from penetration or distress caused by foreign objects shall be repaired or replaced.

No foot traffic will be allowed on the filter fabric except with approved smooth-sole shoes. The Contractor shall not use the filter fabric surface as a work area or storage area for tools and supplies.

Tracked or rubber tired construction equipment shall not be operated directly upon the filter fabric until a minimum thickness of 6 inches of the cover material is placed over the filter fabric. Turning of construction vehicles shall be minimized to avoid distorting or damaging the filter fabric. All damaged filter fabric shall be replaced at Contractor's expense.

3-6. GEOCOMPOSITE SHEET DRAINS INSTALLATION. The prefabricated geocomposite sheet drains shall be installed behind all buried structure walls as indicated on the Drawings. The fabric shall extend beyond the edges of the core to provide overlap for the adjacent panels. Before beginning the backfilling operations the geocomposite drains shall be permanently secured to the walls by means of an attachment system recommended by the manufacturer of the sheet drain. When placing geocomposite sheet drain panels adjacent to each other, the fabric edges shall be overlapped as recommended by the manufacturer. All terminal edges of the sheet drain shall be covered by tucking the filter fabric flap behind the core. The bottom end of the sheet drain to be embedded in the granular drainage material shall have the plastic core exposed by peeling back the fabric a minimum of 3 inches but not so much as to expose the plastic core to intrusion and plugging by soil backfill. Backfill shall be placed and completed within 2 weeks of installation of the sheet drains.

3-7. FINAL GRADING AND PLACEMENT OF TOPSOIL. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches 100 mm Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Any additional topsoil required to provide the required minimum thickness shall be at no additional cost to the Owner.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris.

3-8. DISPOSAL OF EXCAVATED MATERIALS. Suitable excavated materials may be used in fills and embankments as needed. All excess excavated material shall be disposed of off site at the expense of Contractor.

All debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, Contractor.

3-9. RESODDING. All established lawn areas cut by the line of trench, by excavation, or damaged during the work shall be resodded, after completion of construction, to the complete satisfaction of the property owner and Owner. All sod used shall be the same type as removed or damaged, shall be best quality, and, when placed, shall be live fresh growing grass with at least 1-1/2 inches 40 mm of soil adhering to the roots.

All sod shall be procured from areas where soil is fertile and contains a high percentage of loamy topsoil and from areas that have been grazed or mowed sufficiently to form a dense turf.

Sod shall be transplanted within 24 hours from the time it is harvested, unless stacked at its destination in a suitable manner. All sod in stacks shall be kept moist and protected from exposure to the sun and from freezing. In no event shall more than 1 week elapse between cutting and planting.

Before placing sod, all shaping and dressing of the areas shall have been completed. After shaping and dressing, commercial fertilizer of a type acceptable to Owner shall be applied uniformly in the manner and amounts recommended by the manufacturer, and harrowed lightly. Sodding shall follow immediately.

All sodding shall be done during the period from March 15 to October 1, unless written permission is given by Owner to extend the planting season.

3-10. SETTLEMENT. Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.
Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section

Section 02202

TRENCHING AND BACKFILLING

PART 1 - GENERAL

1-1. SCOPE. This section covers clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching; tunneled (trenchless construction) crossings; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other appurtenant work.

1-2. GENERAL. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed or registered professional engineer, to act upon all pertinent matters of the work of this section.

1-3. SUBMITTALS. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittals Procedures section.

At least 30 days before starting construction on the sheeting and shoring, and in accordance with the OSHA requirements identified above, the Contractor shall ensure that the sheeting and shoring design engineer shall complete and submit to Engineer the Protection System Design Certificate (Figure 2-02202) and the Contractor shall use the sheeting and shoring design. If required by the OSHA requirements identified above or to protect existing facilities, the Contractor shall submit a separate certificate for each unique design. If required for protection of existing facilities or as required by the OSHA regulations identified above, the certificate(s) shall be signed and sealed by the registered professional engineer that designed the protection system.

1-3.01. Filter Fabric Data. Complete descriptive and engineering data for the fabric shall be submitted. Data submitted shall include:

A 12 inch square [300 mm] sample of fabric.

Manufacturer's descriptive product data.

Installation instructions.

1-3.02 Embedment and Backfill Materials. Complete test results covering tests performed by an independent commercial testing laboratory retained by the Contractor for all materials described in the Materials Testing section shall be submitted.

1-4. BASIS FOR PAYMENT.

1-4.01. Trench Sheeting. No additional payment above the Contract Price will be made for trench sheeting left in place.

1-5. INSURANCE. Professional liability insurance shall be provided as specified in the Supplementary Conditions section.

PART 2 - PRODUCTS

2-1. MATERIALS.

2-1.01. Filter Fabric. The fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris.

2-1.01.01. Filter Fabric Type A.
Filter fabric Type A shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter Fabric Type A shall be a nonwoven fabric consisting of only continuous chains of polymeric filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties:

Property	Test Method	Unit	Minimum Average Roll Value *
Fabric Weight	ASTM D3776	oz/yd2 [g/m2]	5.7 [193]
Grab Strength	ASTM D4632	lb [N]	155 [689]
Grab Elongation	ASTM D4632	percent	50
Mullen Burst Strength	ASTM D3786	psi [MPa]	190 [1.3]
Apparent Opening Size	CW-02215	U.S. Standard Sieve Size	70 [212 µm]

* Minimum average roll value in weakest principal direction.

2-1.01.02. Filter Fabric Type B. Not used.

2-1.02. Polyethylene Film. Polyethylene film beneath concrete slabs or slab base course material shall be Product Standard PS17, 6 mil [150 mm] minimum thickness.

2-1.03. Tunnel Materials.

2-1.03.01 Tunnel Liner Plates. Not used.

2-1.03.02. Smooth Steel Pipe. Not used.

2-1.03.03. Wood Skids and Blocking. Not used.

2-1.03.04. Casing Insulators. Not used.

2-1.03.05. Stabilized Sand Fill. Not used.

2-1.03.06. End Closure. Not used.

2-1.04. Backfill Materials.

2-1.04.01. Job Excavated Material. Job excavated material may be used for either uncompacted or compacted trench backfill when the job excavated material is finely divided and free from debris, organic material, cinders, corrosive material, and stones larger than 3 inches [75 mm] in greatest dimension. Masses of moist, stiff clay shall not be used.

2-1.04.02. Inundated Sand Fill. Sand fill shall be clean, with not more than 25 percent retained on a No. 4 [4.75 mm] sieve and not more than 7 percent passing a No. 200 [75 µm] sieve, and shall have an effective size between 0.10 and 0.30 mm.

2-1.04.03 Graded Gravel Fill. Graded gravel for compacted trench backfill shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
1 inch [25 mm]	100
3/4 inch [19 mm]	85 – 100
3/8 inch [9.5 mm]	50 – 80
No. 4 [4.75 mm]	35 – 60
No. 40 [425 µm]	15 – 30
No. 200 [75 µm]	5 – 10

The gravel mixture shall contain no clay lumps or organic matter. The fraction passing the No. 4 [4.75 mm] sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2-1.04.04. Granular Fill. Granular fill material shall be crushed rock or gravel. Granular fill shall be free from dust, clay, and trash; shall be hard, durable, and non-friable; and

shall be graded 3/4 inch to No. 4 [19 to 4.75 mm] as defined in ASTM C33 for No. 67 coarse aggregate. Granular fill shall meet the quality requirements for ASTM C33 coarse aggregate.

2-1.05. Controlled Low Strength Material (CLSM) Fill. Not used.

2-1.06. Pipe Embedment Material. Pipe embedment material shall be placed as indicated in Figure 1-02202.

2-1.06.01. Granular Embedment. .Granular embedment shall consist of crushed rock and crushed gravel , meeting the quality and gradation requirements of coarse aggregate size number 7 (13 to 4.75 mm) of ASTM C33.

2-1.06.02. Hand Placed Embedment. Hand placed embedment shall be finely divided job excavated or imported material, free from organic materials, debris, and stones.

2-1.06.03. Compacted Embedment. Compacted embedment shall be finely divided job excavated material free from debris, organic material, and stones. Graded gravel may be substituted for compacted embedment. Granular embedment may be substituted for all or part of the compacted embedment at the option of the Contractor.

2-2. MATERIALS TESTING.

2-2.01. Preliminary Review of Materials. As stipulated in the Quality Control section, all tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of Contractor. Two initial gradation tests shall be made for each type of embedment, fill, backfill, or other material, and one additional gradation test shall be made for each additional 500 tons [450 Mg] of each material delivered to the site. In addition, one set of initial Atterberg Limits test shall be made for each fill materials containing more than 20 percent by weight passing the No. 200 sieve [75 :m]. One additional Atterberg Limits test shall be made for each additional 500 tons [450 Mg] of each material delivered to the site.

All material testing on CLSM shall be made by an independent testing laboratory at the expense of Contractor.

2-2.03. Required Tests. For planning purposes, the following guidelines shall be used for frequency of field tests. Additional tests shall be performed as necessary for job conditions and number of failed tests. Test results shall be submitted as specified in the Submittals Procedures section.

a. Two moisture density (Proctor) tests in accordance with ASTM D698 (or, when required, ASTM D1557), or two relative density tests in accordance with ASTM D4253 and D4254 for each type of general

fill, designated fill, backfill, or other material proposed.

b. In-place field density and moisture tests (ASTM D2922 and ASTM D3017) at intervals of 1000 feet [300 m] maximum along the trench.
c. One in-place field density and moisture test (ASTM D2922 and ASTM D3017) for every 200 cubic yards [153 m^3] of backfill.
d. One in-place density and moisture test (ASTM D2922 and ASTM D3017) whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
e. Additional gradation, Proctor, and relative density tests whenever the source or quality of material changes.

PART 3 - EXECUTION

3-1. CLEARING. All clearing shall be performed as necessary for access, stringing of pipeline materials, and construction of the pipeline and appurtenant structures.

3-2. EXCAVATION. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Except where exterior surfaces are specified to be damp-proofed, monolithic concrete manholes and other concrete structures or parts thereof, which do not have footings that extend beyond the outside face of exterior walls, may be placed directly against excavation faces without the use of outer forms, provided that such faces are stable and also provided that a layer of polyethylene film is placed between the earth and the concrete.

Excavations for manholes and similar structures constructed of masonry units shall have such horizontal dimensions that not less than 6 inches [150 mm] clearance is provided for outside plastering.

3-2.01. Classification of Excavated Materials.

3-2.02. Preservation of Trees. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from permanent damage by construction operations.

For limits of tree removal along pipeline routes, see the limits of disturbance in the drawings.

3-2.03. Blasting. Blasting or other use of explosives for excavation will not be permitted.

3-2.04. Dewatering. Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure or tunnel to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.

Contractor shall be responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

Contractor shall obtain from the appropriate agencies and authorities, the dewatering and stormwater discharge permits required to remove and dispose of groundwater, surface water, and any other water used in Contractor's operations. The permits shall be obtained prior to start of construction.

3-2.05. Sheeting and Shoring. Except where banks are cut back on a stable slope, excavations for structures and trenches shall be supported with steel sheet piling and shoring as necessary to prevent caving or sliding.

Sheet piling or other excavation support systems shall be installed as necessary to limit the extent of excavations for deeper structures and to protect adjacent structures and facilities from damage due to excavation and subsequent construction. Contractor shall assume complete responsibility for, and shall install adequate protection systems for prevention of damage to existing facilities.

Sheeting, shoring and excavation support systems shall be designed by a professional engineer registered in the state where the project is located.

Trench sheeting may be removed if the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting. Trench sheeting shall not be pulled after backfilling. Where trench sheeting is left in place, it shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed. Trench sheeting shall be removed unless otherwise permitted by Engineer. Trench sheeting will not be removed, if in the opinion of Engineer, removal of the sheeting will cause damage to the facility it is protecting. If left in place, the sheeting shall cut off 12 inches below finished

grade. The design of the support system shall be such as to permit complete removal while maintaining safety and stability at all times.

A movable trench support may be used, provided care is exercised in placing and moving the trench box or support bracing to prevent movement of the pipe or disturbance of the pipe bedding and backfill. Any voids left in the trench wall or embedment material by support removal shall be carefully filled with granular embedment material compacted as specified herein.

3-2.06. Stabilization. Sub-grades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.

Sub-grades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel as specified for granular fills. The stabilizing material shall be placed in a manner that no voids remain in the granular fill. All excess granular fill with unfilled void space shall be removed. The finished elevation of stabilized sub-grades shall not be above sub-grade elevations indicated on the Drawings.

3-3. TRENCH EXCAVATION. No more trench shall be opened in advance of pipe laying than is necessary to expedite the work. One block or 400 feet [120 m], whichever is the shorter, shall be the maximum length of open trench on any line under construction.

Except where tunneling is indicated on the Drawings, is specified, or is permitted by Engineer, all trench excavation shall be open cut from the surface.

Prior to excavation, Contractor shall contact local underground alert hotlines, “Dig Safe” and/or individual utility owners for marking underground utilities. Once utilities are marked, Contractor shall hand dig or pothole to expose the existing utilities. A survey shall be made of the utility size, material, location, and elevation prior to trench excavation and information shall be recorded on the record Drawings maintained by the Contractor.

3-3.01. Alignment, Grade, and Minimum Cover. The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the section covering installation of pipe.

3-3.02. Maximum Trench Widths. Not used.

3-3.03. Minimum Trench Widths. Except when maximum trench width is required for certain conduits, trenches shall be excavated to the minimum trench widths indicated in the following table. Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment.

Nominal Pipe Size	Minimum Trench Width	Clearance
Less than 27 in [700 mm]	Pipe OD plus 24 in [600 mm]	12 in [300 mm]
27 in through 60 in [700 mm through 1,500 mm]	Pipe OD plus nominal pipe size	ID/2
Greater than 60 in [1,500 mm]	Pipe OD plus 70 in [1800 mm]	30 in [750 mm]

Clearance = Minimum sidewall clearance
OD = Outside diameter (or span) of conduit
ID = Inside diameter (or span) of conduit.

Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances which will be required to the trench excavation or the trench protective system.

Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits.

3-3.04. Mechanical Excavation. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated, that the rough trench excavation bottom elevation can be controlled, and that trench alignment is such that pipe, when accurately laid to specified alignment, will be centered in the trench with adequate sidewall clearance. Undercutting the trench sidewall to obtain sidewall clearance will not be permitted.

In locations where maximum trench widths are required for designated rigid conduits, mechanical equipment shall be operated so that uniform trench widths and vertical sidewalls are obtained at least from an elevation 12 inches [300 mm] above the top of the installed pipe to the bottom of the trench.

3-3.05. Cutting Concrete Surface Construction. Cuts in concrete pavement and concrete base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1-1/2 inches [40 mm] deep along each side of the trench and along the perimeter of cuts for structures.

Concrete pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6 inches [150 mm] in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than at the top and no undercutting will be permitted. Pavement cuts shall be made to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.

Pavement removal for connections to existing lines or structures shall not exceed the extent necessary for the installation.

Where the trench parallels the length of concrete walks, and the trench location is all or partially under the walk, the entire walk shall be removed and replaced. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and subsequently replaced between existing joints or between saw cuts as specified for pavement.

3-3.06. Excavation Below Pipe Sub-grade. Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, as indicated on Figure 1-02202, to provide for the installation of granular embedment.

Bell holes shall provide adequate clearance for tools and methods used for installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

3-3.07. Artificial Foundations in Trenches. Whenever unsuitable or unstable soil conditions are encountered, Contractor shall notify Engineer immediately. When authorized by the Engineer , trenches shall be excavated below grade and the trench bottom shall be brought to grade with suitable material. In such cases, adjustments will be made in the Contract Price in accordance with the provisions of the General Conditions.

3-3.08. Over-Excavation. Over-excavation carried below the grade, unless authorized by the Engineer, shall be backfilled to the required grade with material acceptable to the Engineer and compacted to the satisfaction of the Engineer, at no additional cost to the Owner.

3-4. PIPE EMBEDMENT. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the requirements indicated on Figure 1-02202 and to the following supplementary requirements.

Embedment material shall contain no cinders, clay lumps, or other material which may cause pipe corrosion.

3-4.01. Embedment Classes.

a. Class A Arch Encasement. When arch encasement is indicated on the Drawings, Class A arch encasement shall be used at all locations so indicated.
When arch encasement is not indicated on the Drawings, Class A arch encasement is not required unless improper trenching or unexpected trench conditions require its use as determined by Engineer.
Concrete and reinforcing steel for Class A arch encasement shall conform to the requirements of the Cast-in-Place Concrete and Concrete Reinforcement sections.

b. Class B Embedment. Class B bedding shall be used for all steel, ductile iron, bar-wrapped concrete, and vitrified clay pipelines, and for all other pipelines not otherwise specified.

c. Class B Special Embedment. Class B special embedment shall be used for HDPE, PVC, ABS, FRP, GRP, steel or stainless steel pipe where the process fluid design maximum temperature is 140° F [60° C] or higher such as for pressurized air service, and when recommended by the pipe manufacturer.

d. Class C Embedment. Class C embedment shall be used for all reinforced concrete and prestressed concrete pipelines.

3-4.02. Embedment for Ductile Iron, Steel, FRP, and PVC Pipelines. Granular embedment for ductile iron, coal tar coated steel, FRP, and PVC pipelines shall be crushed rock or crushed gravel with rounded or subrounded particles. Crushed rock or gravel with sharp edges which could cause significant scratching or abrasion of the pipe or damage to the polyethylene tube protection shall not be used unless otherwise approved by Engineer and all damage is repaired to the satisfaction of Engineer.

Inundated sand may be used for granular embedment in locations where the use of water will cause no damage to adjacent property and where it can be placed and properly compacted without damage to the pipe.

Inundated sand for granular embedment shall be deposited in, or placed simultaneously with the application of water so that the sand is inundated during compaction. During placement, the sand shall be compacted with a mechanical probe type vibrator. Water

shall be allowed to escape or shall be removed during vibration, and no ponding shall be allowed to take place. Inundated sand shall be compacted to 70 percent relative density as determined by ASTM D4253 and D4254. If the required density cannot be achieved, placement and compaction methods shall be altered.

3-4.03. Placement and Compaction.

3-4.03.01. Granular Embedment. Granular embedment material shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.

After each pipe has been graded, aligned, and placed in final position on the bedding material, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof by shovel slicing or other suitable methods to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

Placing and compaction of embedment material shall not damage the pipe coating or polyethylene encasement. Embedment material shall not be dumped directly on the pipe or polyethylene encasement unless a suitable temporary isolation layer such as a 60 mil HDPE sheeting, is used to cover the pipe and polyethylene encasement.

Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.
Granular embedment shall be placed in layers not more than 6 inches (150 mm) deep and compacted as specified.

Each lift of granular embedment material shall be vibrated with a mechanical probe type vibrator or shovel sliced during placement to ensure that all spaces beneath the pipe are filled. Granular embedment shall be placed in maximum lift thickness of 6 inches [150 mm] and compacted. Each lift of embedment material shall be compacted with three passes (round trip) of a platform type vibrating compactor and to at least 70 percent relative density as determined by ASTM D4253 and D4254.

Where indicated on the Drawings or where silt, fine sand, or soft clay soils are encountered below groundwater, migration of soil into the embedment material shall be prevented by installing filter fabric Type A, or by using graded gravel in place of granular embedment. Filter fabric shall be placed on the trench surfaces so that it completely surrounds the embedment material. Joints shall be lapped 12 inches [300 mm].

Unless otherwise indicated on the Drawings, where pipes pass through water-containing embankments, granular embedment material shall be omitted and the trench bottom shall be graded to provide uniform and continuous support for the pipe. The pipe shall be embedded in embankment material containing no rocks or stones. The

embedment material shall be compacted to the same density as the existing embankment or to at least 95 percent relative compaction in accordance with ASTM D698, whichever is higher.

3-4.03.02. Compacted Embedment. .Compacted embedment shall be placed in uniform layers not more than 8 inches (203 mm) thick and compacted to not less than 95% maximum density as determined by ASTM D698.

Where Class C embedment is required, compacted embedment shall be placed to the top of the pipe in all areas where compacted trench backfill is specified and around restrained pipe sections. Placing and compaction of embedment shall not damage the pipe or coating.

3-4.03.03 Hand Placed Embedment. Hand placed embedment shall be placed by hand shovels or using methods that prevent dropping the material for more than 24 inches above the pipe. Hand placed embedment shall be lightly tamped using hand equipment. Care shall be taken so as to not damage the pipe or coating.

3-4.04. Groundwater Barrier. Continuity of embedment material shall be interrupted by low permeability groundwater barriers to impede passage of water through the embedment. Groundwater barriers for sewer lines that contain manholes with cast-in-place bases shall be compacted soil around each manhole, extending through any granular material beneath the manhole, and meeting ASTM D2487 soil classification GC, SC, CL, or ML-CL and shall be compacted to at least 95 percent of maximum density with moisture content within 2 percent of the optimum moisture content (ASTM D698). Material may be finely divided, suitable job excavated material, free from stones, organic matter, and debris.

Groundwater barriers for sewer lines that contain manholes with precast (developed) bases and for all other pipelines shall be soil plugs of 3 feet [1 m] in width, extending the full depth and width of granular material, and spaced not more than 400 feet [120 m] apart. The soil plugs shall be constructed from soil meeting ASTM D2487 classification GC, SC, CL, or ML, and compacted to 95 percent of maximum density at near the optimum moisture content (ASTM D698).

3-5. TRENCH BACKFILL. All trench backfill above pipe embedment shall conform to the following requirements.

A layer of backfill material not more than 8 inches [200 mm] deep may be placed over concrete arch encasement or concrete thrust blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least 3 days.

3-5.01. Compacted Backfill. Compacted backfill will be required for the full depth of the trench above the embedment in the following locations:

Where beneath pavements, surfacings, driveways, curbs, gutters, walks, or other surface construction or structures.

Where in street, road, or highway shoulders.

In established lawn areas.

The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches [300 mm] of topsoil corresponding to, or better than that which is underlying adjoining lawn areas.

Trench backfill material shall be suitable job excavated material and shall be as specified herein.

3-5.01.01. Job Excavated Material. Job excavated materials shall be placed in uniform layers not exceeding 8 inches [200 mm] in uncompacted thickness. Each layer of material shall have the best possible moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as needed and thoroughly mixed to ensure uniform moisture content and adequate compaction. Increased layer thickness may be permitted for noncohesive material if Contractor demonstrates to the satisfaction of Engineer that the specified compacted density will be obtained.

3-5.01.02. Inundated Sand. Not used.

3-5.01.03. Graded Gravel. Not used.

3-5.02. Ordinary Backfill. Compaction of trench backfill above pipe embedment in locations other than those specified will not be required except to the extent necessary to prevent future settlement. Contractor shall be responsible for backfill settlement as specified.

Ordinary earth backfill material to be placed above embedments shall be free of brush, roots more than 2 inches [50 mm] in diameter, debris, cinders, and any corrosive material, but may contain rubble and detritus from rock excavation, stones, and boulders in certain portions of the trench depth.

Backfill material above embedments shall be placed by methods which will not impose excessive concentrated or unbalanced loads, shock, or impact on installed pipe, and which will not result in displacement of the pipe.

Compact masses of stiff clay or other consolidated material more than 1 cubic foot [0.03 m^3] in volume shall not be permitted to fall more than 5 feet [1.5 m] into the trench, unless cushioned by at least 2 feet [600 mm] of loose backfill above pipe embedment.

No trench backfill material containing rocks or rock excavation detritus shall be placed in the upper 18 inches [450 mm] of the trench, nor shall any stone larger than 8 inches [200 mm] in its greatest dimension be placed within 3 feet [900 mm] of the top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

3-5.03. Water-Settled Earth Backfill. Settlement or consolidation of trench backfill using water jetting or ponding shall not be performed.

3-5.04. Structure Backfill. Backfill around manholes and small concrete vaults shall meet the requirements specified for

3-5.05. Controlled Low Strength Material (CLSM). Not used.

3-6. TUNNEL EXCAVATION. Not used.

3-7. DRAINAGE MAINTENANCE. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or watercourses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the trafficway, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other watercourses crossed by the line of trench shall be removed immediately after backfilling is completed, and the original section, grades, and contours of ditches or watercourses shall be restored. Surface drainage shall not be obstructed longer than necessary.

3-8. PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSES. Not used.

3-9. FINAL GRADING AND PLACEMENT OF TOPSOIL. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches [100 mm]. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Topsoil required to provide the minimum thickness shall be imported and placed at no additional cost to the Owner.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris.

3-10. DISPOSAL OF EXCESS EXCAVATED MATERIALS. Disposal of excess material from trench excavations on plant and major facility construction sites shall be accomplished as specified in the Excavation and Fill for Structures section of the Specifications for the major construction.

Disposal of excess material from trench excavation sites shall be as follows. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site.

Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be installed in trench backfill, debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site.

Excess earth from excavations located in unimproved property may be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of 6 inches [150 mm] above the original ground surface elevation at and across the trench and sloping uniformly each way. Material thus wasted shall be carefully finished with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road, or highway right-of-way. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing, shall be a subsidiary obligation of Contractor and no separate payment will be made therefore.

3-11. RESODDING. All established lawn areas cut by the line of trench or damaged during the work shall be re-sodded, after completion of construction, to the complete satisfaction of the property owner and Owner. All sod used shall be the same type as removed or damaged, shall be best quality, and, when placed, shall be live fresh growing grass with at least 1-1/2 inches [40 mm] of soil adhering to the roots.

All sod shall be procured from areas where soil is fertile and contains a high percentage of loamy topsoil and from areas that have been grazed or mowed sufficiently to form a dense turf.

Sod shall be transplanted within 24 hours from the time it is harvested, unless stacked at its destination in a suitable manner. All sod in stacks shall be kept moist and protected from exposure to the sun and from freezing. In no event shall more than 1 week elapse between cutting and planting.

Before placing sod, all shaping and dressing of the areas shall have been completed. After shaping and dressing, commercial fertilizer of a type acceptable to Owner shall be

applied uniformly in the manner and amounts recommended by the manufacturer, and harrowed lightly. Sodding shall follow immediately.

All sodding shall be done during the period from March 15 to October 1, unless written permission is given by Owner to extend the planting season.

3-12. SETTLEMENT. Contractor shall be responsible for all settlement of trench backfill which may occur within the correction period stipulated in the General Conditions.

Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section

SECTION 02224

PIPE BORING AND JACKING

PART 1 – GENERAL

1-1. SCOPE.

The work covered by this Section includes furnishing all labor, materials and equipment required to bore and jack casings or construct tunneled crossings and to properly complete pipeline construction as described herein and/or shown on the Drawings.

General: Supply all materials and perform all work in accordance with applicable American Society for Testing and Materials (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI) or other recognized standards. Latest revisions of all standards are applicable. If requested by the Engineer, submit evidence that manufacturer has consistently produced products of satisfactory quality and performance over a period of at least two years.

1-2. SUBMITTALS.

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1-2.01. Method Submittals: The Contractor shall provide for the Engineer's approval, a detailed plan for the methods proposed for the construction of the casing or tunnel. These plans shall address the following:

1-3. GROUNDWATER CONTROL

The Contractor shall control the groundwater throughout the construction of the casing. The groundwater shall be controlled by dewatering (well points, sumps, or deep wells), grouting, freezing or other method approved by the Engineer. The Contractor shall prepare a written, detailed plan for controlling the groundwater, citing similar installation conditions and results. This plan is to be submitted to the Engineer prior to any construction for the casing.

1-4. FACE PROTECTION:

The face of the excavation shall be protected from the collapse of the soil into the casing or tunnel.

1-5. CASTING DESIGN:

Design of the bore pit and required bearing to resist jacking forces are the responsibility of the Contractor. The excavation method selected shall be compatible with expected ground conditions. The lengths of the casing shown on the Drawings are the minimum lengths required. The length of the casing may be extended for the convenience of the

Contractor, at no additional cost to the City. Due to restrictive right-of-way and construction easements, boring and jacking casing lengths less than the nominal 2 foot length may be necessary.

1-6. BORE AND JACK METHOD.
The Contractor has the option to select the bore and jack method, including groundwater control, except as restricted herein.

Submit working drawings, written procedure, and calculations describing in detail the proposed bore and jack method and entire operation. This shall include, but not be limited to, groundwater control, ground stabilization if proposed, excavation procedures, control of casing alignment and grade, support of face, detection of surface movement, procedure for installing pipes and anchors and placement of grout between pipe and casing. If, in opinion of the Contractor, modifications to the methods are required during construction, working drawings shall be submitted delineating such modifications, including reasons for the modifications.

1-7. TUNNELING METHOD.

1-7.01 Material Submittals: The Contractor shall provide for the Engineer's approval, shop drawings, proposed construction drawings and other pertinent specifications and product data as follows:

Shop drawings for casing pipe and tunnel liner plate showing sizes and connection details.

Design mixes for concrete and grout.

Casing Spacers.

1-8. EXPERIENCE SUBMITTALS.
Boring and jacking casings and tunnel construction is deemed to be specialty contractor work. If the Contractor elects to perform the work, the Contractor shall provide evidence of experience as required by the General Conditions. A minimum of five continuous years of experience in steel casing and tunnel construction (as applicable) is required of the contractor proposed to do the work. Evidence of this experience must be provided with the shop drawings for review by the Engineer.

1-9. STORAGE AND PROTECTION.
All materials shall be stored and protected in accordance with the manufacturer's recommendations and as approved by the Engineer.

PART 2 – PRODUCTS

2-1. MATERIALS AND CONSTRUCTION

2-1.01. Casing: The casing shall be new unused pipe made from steel plate having minimum yield strength of 35,000 psi. The steel plate shall also meet the chemical requirements of ASTM A 36.

The outside of the casing pipe shall be coated with coal tar epoxy having a minimum dry film thickness of 16 mils. Surface preparation shall be SSPC-SP-10. Epoxy shall have a minimum solids content of 65 percent by volume and shall be air or airless spray applied, minimum drying time shall be seven days. Brushing shall be permitted in small areas only. All coating and recoating shall be done in strict accordance with the manufacturer's recommendations. Epoxy shall be Tnemec, Kop-Coat or Valspar.

Minimum casing thicknesses are shown on the Drawings. Actual thicknesses shall be determined by the casing installer, based on an evaluation of the required forces to be exerted on the casing when jacking. Any buckling of the casing due to jacking forces shall be repaired at no additional cost to the City.
Minimum diameters of casing are shown on the Drawings. Larger casings, with the

Engineer’s approval may be provided at no additional cost to the City, for whatever reasons the Contractor may decide, whether due to casing size availability, line and grade tolerances, soil conditions, etc.

2-1.02. Liner Plate. Liner plates shall be of the thickness shown on the Drawings. The liner plates shall be either the 4-flange type or the 2-flange lap-joint type. Bolts and nuts used with the 2-flange plates shall be a minimum of 5/8 inch in diameter and shall conform to the latest revision of ASTM A 307 for plate thickness less than 0.209 inch, and ASTM A 449 for plate thickness equal to or greater than 0.209 inch. Bolts and nuts used with 4-flange plates shall be not less than ½ inch in diameter for plate thicknesses to and including 0.179 inch and not less than 5/8 inch in diameter for plates of greater thickness. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM A 307, Grade A. Each ring shall have 2-inch diameter half couplings and plugs for grouting, located as shown on the detailed drawings.

2-1.03. Casing Spacers: Casing spacers shall meet one of the following requirements: Casing spacers shall be flanged, bolt-on style with a two-section stainless steel shell lined with a PVC liner, minimum 0.09-inch thick also having a hardness of 85-90 durometer. Runners shall be attached to stainless steel risers which shall be properly

welded to the shell. The height of the runners and risers shall be manufactured such that the pipe does not float within the casing. Casing spacers shall be Cascade Waterworks Manufacturing Company, Advanced Products & Systems, Inc., or equal.

Casing spacers shall be a two-section, flanged, bolt on style constructed of heat fused PVC coated steel, minimum 14 gauge band and 10 gauge risers, with 2-inch wide fiberglass reinforced polyester insula duty PVC inner liner, minimum 0.09-inch thick, having a hardness of 85-90 durometer, and all stainless steel hardware shall be Pipeline Seal and Insulator, Ltd., or equal.

Casing spacers shall be designed for the general configuration shown in the Plans, including provisions for other conduits to be installed with the carrier pipe.

2.01.04. Carrier Pipe: Carrier pipes shall be as specified in Section 02665, Water Mains and Accessories and Section 02667, Large Water Transmission Mains. All joints of pipe in casing shall be restrained.

2-1.05. Surface Settlement Markers: Surface settlement markers within pavement areas shall be P.K. nails. Surface settlement markers within non-paved areas shall be wooden hubs.

2-2. EQUIPMENT.

2-2.01. Casings. A cutting head shall be attached to a continuous auger mounted inside the casing pipe.

On casing pipe for water lines over 60 feet in length, the installation equipment shall include a steering head and a grade indicator.

The steering head shall be controlled manually from the bore pit. The grade indicator shall consist of a water level attached to the casing, which would indicate the elevation of the front end of the casing or some other means for grade indication approved by the Engineer.

2-3. Tunnels

2-3.01. Tunnel Boring Machine (TBM). The TBM shall be equipped with disc cutters of diameter 19 inches or greater designed for operation at thrusts of up to 70 kips per cutter.
The TBM shall afford adequate protection against loss of ground and permit ground support adjacent to the tunnel face, as required by ground conditions.

The TBM shall be equipped with a dust control system which includes a water spray system, dust shield and dust scrubber system.

The method used to advance the TBM shall ensure its correct alignment at all times, without binding or imposing excessive loads on the primary tunnel supports or upon the surrounding ground.

The TBM shall be equipped with a roll indicator and laser target system, which allows the operator to observe the machine's alignment and orientation (predictor system) from the control station.

The TBM shall be grounded in accordance with the latest requirements of the National Electrical Code and equipped with ground fault protection.

2-3.02. Other tunneling Equipment. Power machinery and tools within the tunnel shall be operated by either electricity, compressed air, diesel with approved scrubber or other approved power. Electrical tools and equipment shall be grounded in accordance with the latest equipments of the National Electrical Code.

All electrical equipment and power receptacles shall have appropriate ground fault protection.

Provide temporary electrical lights to properly and safely illuminate all part of the shafts and tunnel including special illumination at the working face. Lighting circuits shall be thoroughly insulated and separated from power circuits, and lights shall be enclosed I wire cages. Secure electrical permits required for successful completion of this work.

PART 3 – EXECUTION

3-1. GENERAL.

Interpretation of soil investigation reports and data, investigating the site and determination of the site soil conditions prior to bidding is the sole responsibility of the Contractor. Rock and/or water, if encountered, shall not entitle the Contractor to additional compensation.

When water is encountered, provide and maintain a dewatering system of sufficient capacity to remove water on a 24-hour basis keeping excavations free of water until the backfill operation is in progress. Dewatering shall be performed in such a manner that removal of soil particles is held to a minimum. Dewater into a sediment trap and comply with requirements specified in Section 02125, Temporary and Permanent Erosion and Sediment Control.

Methods of dewatering shall be at the option and responsibility of the Contractor. Maintain close observation to detect settlement or displacement of surface facilities due to dewatering. Should settlement or displacement be detected, notify the Engineer immediately and take such action as necessary to maintain safe conditions and prevent damage.

Casing and tunnel construction shall be performed so as not to interfere with, interrupt or endanger roadway surface and activity thereon, and minimize subsidence of the surface, structures, and utilities above and in the vicinity of the work. Support the ground continuously in a manner that will prevent loss of ground and keep the perimeters and face of the casing, passages and shafts stable. The Contractor shall be responsible for all settlement resulting from operations and shall repair and restore damaged property to its original or better condition at no cost to the City.

3-2. SAFETY.

Provide all necessary bulkheads and shields to ensure complete safety to all traffic, persons and property at all times during the work. Perform the work in such a manner as to not permanently damage the roadbed or interfere with normal traffic over it in those areas immediately adjacent and outside the active project work area. Observe and comply with all applicable requirements of GDOT. Conduct the operations in such a manner that all work will be performed below the level of the roadbed. Perform all activities in accordance with the Occupational Safety and Health Act of 1970 PL-596), as amended, applicable regulations of the Federal Government, OSHA 29CFR 1926 and applicable criteria of ANSI A10.16-81, "Safety Requirements for Construction of Tunnel Shafts and Caissons".

3-3. SURFACE SETTLEMENT MONITORING.

Provide surface settlement markers, placed as specified and as directed by the Engineer. The Contractor shall place settlement markers outside of pavement area, along the centerline of the casing or tunnel at 20 foot intervals. Markers shall also be placed at each shoulder of the roadway, at each edge of pavement, at the centerline of the pavement and at 10 and 25 feet offset in each direction from the centerline of the casing. Tie settlement markers to bench marks and indices sufficiently removed as not to be affected by the Contractor’s operations.

Make observations of surface settlement markers, placed as required herein, at intervals acceptable to the Engineer. In the event settlement or heave on any marker exceeds 1-inch, the Contractor shall immediately cease work and using a method approved by the Engineer, take immediate action to restore surface elevations to those existing prior to start of Contractor’s operations.

Take readings and permanently record surface elevations prior to start of dewatering operations and/or shaft excavation. The following schedule shall be used for obtaining and recording elevation readings: all settlement markers, once a week; all settlement markers within 50 feet of the casing or tunnel heading, at the beginning of each day; more frequently at the Engineer's direction if settlement is identified. Make all elevation measurements to the nearest 0.01 foot.

The Contractor shall cooperate fully with jurisdictional personnel. Any settlement shall be corrected by, and at the expense of, the Contractor.

Promptly report any settlement and horizontal movement immediately to the Engineer and take immediate remedial action, at no cost to the City.

3-4. BORING AND JACKING

3-4.01 Shaft. Conduct boring and jacking operations from a shaft excavated at one end of the section to be bored. Where conditions and accessibility are suitable, place the shaft on the downstream end of the bore.

The shaft shall be rectangular and excavated to a width and length required for ample working space. If necessary, sheet and shore shaft properly on all sides. Shaft sheeting shall be timber or steel piling of ample strength to safely withstand all structural loadings of whatever nature due to site and soil conditions. Keep preparations dry during all operations. Perform shaft dewatering operations as necessary.

The bottom of the shaft shall be firm and unyielding to form an adequate foundation upon which to work. In the event the shaft bottom is not stable, excavate to such additional depth as required and place a gravel sub-base or a concrete sub-base if directed by the Engineer due to soil conditions.

3-4.02. Jacking Rails and Frame. Set jacking rails to proper line and grade within the shaft. Secure rails in place to prevent settlement or movement during operations. The jacking rails shall cradle and hold the casing pipe on true line and grade during the progress of installing the casing.
Place backing between the heels of jacking rails and the rear of the shaft. The backing shall be adequate to withstand all jacking forces and loads.

The jacking frame shall be of adequate design for the magnitude of the job. Apply thrust to the end of the pipe in such a manner to impart a uniformly balanced load to the pipe barrel without damaging the joint ends of the pipe.
Boring and jacking of casing pipes shall be accomplished by the dry auger boring method without jetting, sluicing or wetboring.

Auger the hole and jack the casing through the soil simultaneously.

Bored installations shall have a bored-hole diameter essentially the same as the outside diameter of the casing pipe to be installed.

Execute boring ahead of the casing pipe with extreme care, commensurate with the rate of casing pipe penetration. Boring may proceed slightly in advance of the penetrating pipe and shall be made in such a manner to prevent any voids in the earth around the outside perimeter of the pipe. Make all investigations and determine if the soil conditions are such as to require the use of a shield.

As the casing is installed, check the horizontal and vertical alignment frequently. Make corrections prior to continuing operation.

Any casing pipe damaged in jacking operations shall be repaired, if approved by the Engineer, or removed and replaced at Contractor's own expense.

Lengths of casing pipe, as long as practical, shall be used except as restricted otherwise. Joints between sections shall be completely welded in accordance with AWS recommended procedures. Prior to welding the joints, the Contractor shall ensure that both ends of the casing sections being welded are square.

The Contractor shall prepare a contingency plan which will allow the use of a casing lubricant, such as bentonite, in the event excessive frictional forces jeopardize the successful completion of the casing installation.

Once the jacking procedure has begun, it should be continued without stopping until completed, subject to weather and conditions beyond the control of the Contractor. Care shall be taken to ensure that casing pipe installed by boring and jacking method will be at the proper alignment and grade.

The Contractor shall maintain and operate pumps and other necessary drainage system equipment to keep work dewatered at all times.

Adequate sheeting, shoring and bracing for embankments, operating pits and other appurtenances shall be placed and maintained to ensure that work proceeds safely and expeditiously. Upon completion of the required work, sheeting, shoring and bracing shall be left in place, cut off or removed, as directed by the Engineer.

Refer to Section 02200, Earthwork and Section 02324, Trenching and Trench Backfilling for additional information related to trench excavation, all classes and types of excavation, the removal of rock, muck and debris, and the excavation of all working pits and backfill.

3-5. TUNNELS

3-5.01. Shaft Excavation. Excavate in such a manner that overbreak is held to a minimum. In soil and mixed face conditions, install primary support in continuous and close contact with the excavated surface to control water inflow and prevent ground loss, so that adjacent structures are not affected by ground movements. Excavation in soil shall not be advanced ahead of the previously installed primary support any more than is necessary for the installation of the succeeding section of primary support.

Whenever shaft sinking is suspended, complete prairie support to the excavated surfaces and keeps any dewatering system operating. The Contractor shall have

qualified personnel periodically check conditions that might threaten the excavation stability.

Remove excavated soil and rock from the site and dispose of properly at a location secured by the Contractor.

Remove sheeting used for shoring from the shaft and off the job site. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either new or existing structures, private or public properties and also to avoid cave-ins or sliding in the banks.

3-5.02. Tunnel Excavation. Excavate in such a manner that overbreak is held to a minimum.

Where water inflows in the tunnel face are large and increasing, the Engineer may instruct the Contractor to drill probe holes, relief holes and ground treatment holes in the tunnel face, and to carry out consolidation grouting before proceeding.

Whenever tunneling is suspended, complete installation of the primary support for that excavation cycle. Have qualified personnel periodically check conditions that might threaten tunnel stability.

Remove excavated rock from the excavation of the TBM erection, transit and reception chambers and dispose of properly at a location secured by the Contractor.

The liner plates shall be installed progressively as excavation proceeds. Excavation shall not continue more than 24 inches past the end of the liner plate already in place.

At this time an additional section of liner shall be installed before excavation shall continue. Grout shall be placed under pressure in the annular void as the excavation proceeds. Grout should be continuously placed as close to the heading as possible, using grout stops if necessary. Grout shall be injected in the lower holes first, moving upward as the back space is filled. Threaded plugs shall be installed after filling each grout hole.

3-6. VENTILATION AND AIR QUALITY

Provide, operate and maintain for the duration of casing project a ventilation system to meet safety and OSHA requirements.

3-7. ROCK EXCAVATION IN CASING

In the event that rock is encountered during the installation of the casing pipe which, in the opinion of the Engineer, cannot be removed through the casing, the Engineer may authorize the Contractor to complete the crossing with a tunnel.
At the Contractor's option, the Contractor may continue to install the casing and remove the rock through the casing at no additional cost to the City.

3-8. INSTALLATION OF PIPE

After construction of the casing or tunnel is complete, and has been accepted by the Engineer, install the pipeline in accordance with the Drawings and Specifications. Check the alignment and grade of the casing and submit a plan to the Engineer for approval to set the pipe at proper alignment, grade and elevation, without any sags or high spots.

The carrier pipe shall be held in the casing pipe by the use of casing spacers. The casing spacers shall be designed by the Contractor such that the carrier pipe can be installed in the casing. For tunnels, the carrier pipe will be held in place with a steel strap per the details.

Close the ends of the casing or tunnel with 4-inch brick walls plastered with Portland cement mortar and waterproofed with asphaltic roofing cement.

3-9. SHEETING REMOVAL

Remove sheeting used for shoring from the shaft and off the job site. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either new or existing structures, private or public properties and also to avoid cave-ins or sliding in the banks.

END OF SECTION

Section 02370

CONTINUOUS FLIGHT AUGER PILES

PART 1 - GENERAL

1-1. SCOPE. This section covers design, materials and installation of continuous flight auger (CFA) piles. Load testing of CFA piles is specified in Section 02371. Contractor shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete piling work as specified herein.

1-2. QUALITY ASSURANCE

1-2.01. Reference Standards: Federal Highway Administration (FHWA) Geotechnical Engineering Circular No. 8, “Design and Construction of Continuous Flight Auger Piles”.

1-2.02. Contractor Experience. The CFA pile Subcontractor shall have a minimum of five (5) years of experience and shall have satisfactorily completed at least three (3) projects requiring the installation of CFA piles of 18-inch or larger diameter and 70 foot or longer length. Provide a complete description of each project including the names, current telephone numbers and addresses of the owners or consultants with a description of the site geology; equipment, tools and facilities used in pile construction; and pile sizes and lengths, installation criteria and load test reports. Provide on-site supervision personnel specializing (foreman, superintendent, and drill rig operators) in the installation of CFA piles who can demonstrate similar experience.

1-2.03. CFA Pile Designer. The CFA pile Subcontractor shall provide the services of a professional engineer licensed in Georgia with experience in the design of at least three (3) successfully completed projects over the past five (5) years with CFA pile foundation support of similar capacity to those required for the Work to perform the following tasks:

1. Supervise preparation of CFA pile work plan and design drawings. Sign and seal design drawings and work plans submitted for review and acceptance.
2. Quality control testing during construction will be performed by an independent testing laboratory retained by Owner.
3. Certify conformance of construction submittals with release for construction design documents.

4. Observe the installation and testing of all technique and test piles. Periodically observe the installation and testing of at least ten (10) percent of the production piles to confirm general conformance with design requirements.

5. Develop (and finalize in written reports) corrective action plans for any unacceptable CFA piles due to non-conforming installation or testing.

1-2.04. Surveying and Testing Services. Land surveying services provided for CFA pile construction shall be performed under the direction of professionals licensed to practice in Georgia.

A qualified independent testing agency may be engaged by the Contractor to sample pile grout materials and perform tests and measurements during pile installation.

1-2.05. Preinstallation Meeting. Contractor shall schedule a meeting a minimum of 7 days prior to the installation of piles for coordination of all related activities with the pile Subcontractor, CFA pile designer, pile Subcontractor's load test engineer, Owner, Engineer and Resident Project Representative.

1-2.06. Pile Installation Tolerances. The location of each pile shall be determined by surveying. The maximum deviation of any pile from its plan location indicated on the Drawings shall not be more than three (3) inches at its top elevation. Vertical piles shall be installed plumb within a tolerance of two percent (2%) of vertical. Costs of redesign or extra construction caused by piles installed out of tolerance shall be paid by the Contractor at no additional cost to Owner.

1-3. SUBMITTALS. Submittals of data and drawings shall be in accordance with Section 01300.

1-3.01. DESIGN DOCUMENTS:

1. CFA pile design engineer qualifications.
2. Design work plan and Working Drawings for CFA pile installation.
3. CFA pile design calculations shall include, but not be limited to, the following items:
    A. Written summary report describing the overall CFA pile design.
    B. Applicable code requirements and references.
    C. CFA pile structure critical design cross-section(s), including soil strata, assumed piezometric levels, and location, magnitude and direction of applied loads.
    d. Design criteria, including soil shear strengths (friction angle and cohesion), unit weights, unit skin friction values, and unit end-bearing values. Any additional subsurface borings, cone penetrometer tests, laboratory work, or other subsurface data collected for the design by Contractor shall also be included.
    e. The CFA piles shall be designed for a minimum ultimate axial load of two times the service load capacity indicated on the drawing.

f. Design calculation sheets with the project number, CFA pile structure location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. An index page shall be included with the design calculations.

g. Design notes including an explanation of symbols and computer programs used in the design.

Working Drawings shall include, but not be limited to: Scaled plan view of CFA pile locations for each supported structure identifying:

1) Reference baseline datum.

2) CFA pile identification numbers.

3) Location of adjacent structures or other potential interferences.

4) Proposed technique and test pile locations as approved by the Engineer.

5) Subsurface exploration locations performed by the Contractor.

CFA pile schedule Pile Summary Table shall include all production pile lengths and tip elevations based on the evaluations of the pile load test(s) and any additional subsurface explorations performed by Contractor.

General notes for constructing the CFA pile including sequencing, drilling, grout placement, top sleeve placement and trimming, reinforcement placement, grout testing, and grout curing provisions.

CFA pile typical sections including diameter, length, reinforcing bar sizes, locations, spacing, and details; centralizers and spacers; and connection details to the substructure foundation.

Details, dimensions, and schedules for all piles and reinforcing steel.

1-3.02 Construction Documents: CFA pile Contractor and supervisory personnel (foreman, superintendent, and operator) qualifications. CFA pile installation plan including, but not be limited to, the following items:

A. List and sizes of proposed equipment, including drill rigs, augers and other drilling tools, pumps for grout, mixing equipment and automated monitoring equipment.

B. Material certifications and test reports.

C. Step-by-step description of pile installation procedures;

D. A scaled drawing showing the sequence of pile installation for each CFA pile supported structure;

E. Target drilling and grouting parameters (along with acceptable ranges) for pile installation, including auger rotation speed, drilling penetration rates, torque, grout pressures, and grout volume factors;

F. Details of methods of reinforcement placement, including support for reinforcing cages at the top of the pile and methods for centering the cages within the grout column;

G. Mix designs for all grout to be used on the project, including laboratory tests of the proposed mix designs, and slump loss vs. time curves and strength development vs. time curves for mixes;

H. Description of PIR-A pile installation recorder as supplied by Pile Dynamics, Inc. of Cleveland, Ohio, or equal;

I. Contingency plans for equipment failures during drilling or grouting operations (grout pump, monitoring equipment, etc.);

J. Sample of pile installation records.

K. Spoils Disposal Plan.

Pile Summary Table with all production pile lengths and tip (bottom) elevations indicated (as established from the pre-production testing program results).

Updated Working Drawings and CFA pile Installation Plan to indicate changes in pile installation criteria such as target drilling and grouting parameter etc. based on results of pre-production pile testing program.

1-3.03 Record Documents: As-built pile location plan showing the exact locations, cutoff elevations and deviations of all CFA pile piles, based upon a survey completed prior to foundation placement of mat.

Pile Installation Record: At end of each work day, submit two copies of each record for every pile constructed that day including PIR-A print out. Include copies of all grout delivery tickets and identification of all grout test cylinder numbers associated with the CFA pile grout.

Spreadsheet of PIR-A installation data.

Revised mix design when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1-4. BASIS FOR PAYMENT. The CFA piles shall be paid as a Lump Sum that includes all production piles, technique pile(s) and test pile(s) and any subsurface explorations performed by the Contractor.

PART 2 - PRODUCTS

2-1. MATERIALS. Materials used in the construction of CFA piles shall conform to the following. Any additional products required to complete Subcontractors pile design shall be acceptable to the Engineer.

Cement	As specified in Section 03300.
Fly Ash	As specified in Section 03300.
Fine Aggregate	As specified in Section 03300.
Water	As specified in Section 03300.
Fluidifier	ASTM C937.
Retarder	ASTM C494, Type F
Viscosity Modifier	ASTM C494, Type S
Reinforcing Steel	As specified in Section 03200.
Bars, Nonweldable	As specified in Section 03300.
Center Bars	ASTM A615 Grade 75

2-2. PILE INSTALLATION LOGS. The pile installation form shall be acceptable to the Engineer and shall contain the unique pile identification number for each pile, pile tip (bottom)elevation, pile cutoff (top) elevation, description and depth of any obstructions, pile length, diameter, theoretical volume of grout required, and actual volume of grout pumped in each pile and print out from the PIR-A installation recorder.

2-3. MIX DESIGN. The mix design shall comply with requirements of the paragraph of this specification titled “Proportioning”. Unless otherwise specified, tolerances for grout work shall be as stipulated in Article 2.4 of ACI 117. Design quantities and test results of each mix shall be submitted for review. All tests and reports required for mix design review shall be made by an independent testing laboratory at the expense of the Contractor. The mix design shall be reviewed and accepted by Engineer prior to pile installation.

2-3.01. Grout Testing. Two (2) sets of compression test cylinders, three (3) cylinders per set, shall be made from each proposed grout mix. One (1) set of three cylinders shall be tested at an age of 7 days and the other set shall be tested at an age of 28 days. Grout test specimens shall be made, cured, and stored in conformity with ASTM C192, except molds shall be 3 inch diameter by 6 inches high. Grout test specimens shall be tested in conformity with ASTM C39. The Contractor may substitute strength data based on compression testing of 2 inch cubes, provided the cube test breaks exceed the herein specified 7 and 28 day strengths by 10 percent (10%). Test cubes shall be made, cured, and tested in accordance with ASTM C109.

2-3.02. Mix Design Report. The report for each tentative grout mix submitted shall contain the following information:

Total gallons of water per cubic yard.
Brand, type, composition, and quantity of cement.
Brand, type, composition, and quantity of fly ash.

Specific gravity and gradation of aggregate.
Weight (surface dry) of aggregate per cubic yard.
Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.
Compressive strength based on 7 day and 28 day compression tests.

2-4. PROPORTIONING. Grout shall be shall consist of a mixture of Portland cement, fine aggregate, water, and at Contractor's option, fluidifier, retarder, viscosity modifier, and fly ash or slag cement. Unless otherwise acceptable to the Engineer, all admixtures shall be from one manufacturer and shall be compatible. The grout shall be proportioned and mixed as recommended by the manufacturer of the admixtures to produce a mixture capable of maintaining the solids in suspension without appreciable water gain; that may be pumped without difficulty; which will fill the augered hole; and that will produce a hardened grout with a minimum compressive strength in the field of 3,000 psi at 7 days and 4,000 psi at 28 days. The laboratory compressive strength of the design mix at 28 days shall be 5,200 psi and 5,800 psi for strength testing of laboratory mix design using cylinders and cubes, respectively.

Fly ash may be substituted for Portland cement within the range of 15 to 25 percent, on the basis of 1.0 pound of fly ash added for each pound of Portland cement reduction. Contractor may substitute slag cement for Portland cement within the range of 25 to 50 percent on the basis of 1.0 pound of slag cement added for each pound of Portland cement reduction. Mixtures using slag cement in combination with fly ash will not be acceptable.

The grout shall have an efflux time of 10 to 25 seconds when tested in accordance with ASTM C 939, using a flow cone that has been modified to a 0.75-in. opening. The grout mix shall be designed to maintain fluid consistency within the specified efflux time for a period of at least two (2) hours, but in no case less than the time required to complete a pile and place the reinforcement.

2-5. BATCHING AND MIXING. Batching and mixing shall be in accordance with ASTM C94. The measurement of sand and cement shall be by weight. Sand weights shall be adjusted for the moisture content. Each admixture shall be dispensed by a mechanical device that provides accurate and automatic measurement.
The minimum amount of water required to produce the desired flow shall be batched automatically. Additional water that may be required to produce and maintain a uniform flow shall be added manually by the mixer operator. Flows shall be kept uniform.

Grout shall be mixed until all ingredients are uniformly distributed throughout the batch. Mixers shall not be loaded in excess of their rated capacities. Each batch shall be completely discharged before recharging the mixer.

A delivery ticket shall be prepared for each load of ready-mixed grout and shall indicate: the mix identification, the number of yards delivered, quantities of each material in the

batch, outdoor temperature in the shade, time at which the cement was added, and the numerical sequence of the delivery. A copy of each ticket shall be handed to the Engineer by the truck operator at the time of delivery. After the addition of water to the cement and aggregates, truck mixers shall discharge within 1-1/2 hours and before the mixing drum makes 300 revolutions. In hot weather, or under conditions contributing to quick stiffening of the grout, a time less than 1-1/2 hours may be required by the Engineer. These limits may be waived by the Engineer or Owner's representative if the grout mix is confirmed by flow cone testing to be in a flowable state to allow placement without addition of water to the mix. Grout shall not be placed when its temperature exceeds 100ºF.

PART 3 - EXECUTION

3-1. EQUIPMENT WORKING SURFACE. The Contractor is responsible for the costs associated with measures required to establish the working surface to support drill rigs, cranes, and other support equipment used to install the piles. The Contractor will be responsible for construction delays and the cost of repair of any damaged piles that result from inadequate stabilization of the equipment working surface. After installation of the piles, the Contractor is responsible for cost of additional materials, equipment, and labor required for preparing subgrade for placement of foundation mat.

3-2. TECHNIQUE PILE. A technique pile (non-production pile) shall be installed prior to installing the test pile. The technique pile shall have the same diameter as the test pile. The purpose of the technique pile is to demonstrate the adequacy of methods and equipment for the pile construction. The technique pile shall be installed at a location acceptable to the Engineer. The length of the technique pile shall be same as production pile length as indicated on the CFA pile Subcontractor's Working Drawings. Once approval has been given by Engineer to proceed with production piles based on satisfactory results for the technique pile and after acceptance of the load test report by the Engineer, no changes shall be made to methods and equipment used for constructing the production pile unless approved by the Engineer. The manufacturer's make and model of drill rigs and drill tooling used to install production piles shall be identical to the drill rig and drill tooling use to install the technique pile(s) and test pile(s).

3-3. TEST PILE. A load test shall be performed on a sacrificial test pile (non-production pile) in accordance with specification Section 02466. No production piles shall be installed until the Engineer has accepted the load test report and any modifications to pile design based on findings of the load test. The Contractor shall plan on a minimum of 21 working days between completion of pile load test and notification from Engineer to proceed with production pile installation.

3-4. EQUIPMENT**.** Equipment used by the CFA pile Subcontractor for installing continuous flight auger piles shall be adequate for the site and subsurface condition. The drilling system shall be designed to prevent auger creep while drilling and shall have the ability to drill at a rate that avoids drawing surrounding soils laterally into the pile bore (i.e. avoids soil mining). Crane mounted CFA pile rigs shall include a torque or stabilizing arm to resist rotation and movement of the pile leads. The minimum applied torque of drill rig shall be 35,000 ft.-lbs and the minimum weight applied to drill tip shall be 5,000 pounds.

3-4.01. Auger Equipment**.** Piles shall be drilled with a continuous hollow flight auger to produce a pile with the minimum diameter shown on the Subcontractor's working drawings. Augers shall be designed to drill a straight clean hole and to continuously remove all auger cuttings from the hole. Auger flights shall be continuous from the top of the auger to the bottom tip of the cutting face of the auger, with no gaps or other breaks and shall have a minimum 2-1/2 inch inside diameter hollow stem. Gaps in the flights are allowed only where auger sections are joined and may not exceed 1 inch. The length of any auger brought to the project site shall be such that the auger is capable of installing a pile to a depth of 15 feet longer than length indicated on the working drawings.

The flights shall be uniform in diameter throughout the auger length, and the outside diameter of the auger shall be at least 97% of the design diameter of the pile. Only single helix augers shall be used. Auger cutting teeth shall be inspected for wear and shall be replaced if the specified reduction in diameter tolerance is reached. The hollow stem of the auger shall be maintained in a clean condition throughout the construction operation. To facilitate inspection, the pile leads shall be clearly marked every 1 ft along its length with marks visible to the unaided eye from the ground.

The bottom of the auger flights and the cutting teeth shall be constructed geometrically so that the bottom of the pile will be as flat as feasible. The grout or grout injection port shall be fitted with a plug to prevent ingress of water and soil during drilling.

The discharge port at the tip of the auger shall be directed straight down or at an angle with the vertical and shall be located at the bottom of the augers, below the cutting teeth. Straight side (horizontal) discharge bits will not be permitted. Bits shall be periodically checked for missing teeth and teeth with excessive wear. Damaged or worn teeth shall be replaced.

3-4.02. Grouting Equipment. The grout pump shall be a positive displacement pump with a known volume per stroke. The grout pressures measured at the pump discharge shall be a minimum of 350 psi. The pump shall be sized appropriately to the pile size such that a smooth, continuous delivery of grout can be maintained while limiting the pressure variations (particularly the pressure drop) at the pile due to the pump strokes. In addition to the PIR-A, the equipment shall contain pressure gauges that monitor the pressure at the pump discharge and in line as close to the auger head as possible. The pressure gauges shall be mounted where they can be continuously monitored by the pump operator and the Engineer. One additional pressure gauge shall be located near the pile rig to facilitate pile installation monitoring. The pile Subcontractor shall keep a minimum

of two (2) spare functional pressure gauges on site during performance of the work. The grout and power unit operators shall have a direct line of sight with the driller. A screen to remove oversize particles shall be placed at the pump inlet.

The Contractor shall submit to the Engineer the value of the volume of grout delivered by each stroke of the pump. The grout pump shall be calibrated prior to installing piles to demonstrate to the Engineer that the actual volume delivered by each stroke of the pump is within 3% of the value submitted. The volume per stroke shall be recalibrated when the Engineer suspects that the grout delivery performance has changed.

In addition to the PIR-A, metering equipment for measuring the flow of grout into each hole shall be provided. This equipment shall be directly coupled to the pumping equipment and shall consist of either a functional stroke counter that has been calibrated for accuracy at the jobsite. The grout pump shall be calibrated at the beginning of the work to determine the volume of grout pumped per stroke.

3-4.03. Automatic Measurement and Recording Equipment. Each drill rig shall be equipped with automated measuring and recording equipment to provide real time evaluation of each pile installed on the Project. The automated measuring and recording equipment shall be a PIR-A pile installation recorder as supplied by Pile Dynamics, Inc. of Cleveland OH, or equal. The PIR-A shall record appropriate information during both the drilling phase and the grouting phase of the installation to assure that a minimum grout volume is pumped per unit depth increment, and shall print the results immediately upon completion of each pile.

The PIR-A shall not replace the manual recording of pile installation information by the Contractor, but shall provide an independent means of providing the information. If there are noticeable differences between manually recorded data and that developed using the PIR-A, such differences shall be reconciled by Contractor to the satisfaction of Engineer. Pile installation operations shall be suspended until the differences are reconciled.

All automatic measurements shall be referenced to (or plotted against) the depth of the auger injection point. This shall be accomplished with a rotational position indicator on the auger head system and an electronic depth sensor on the boom holding the auger, and with flow meters and electronic pressure transducers placed in the grout pressure line.

As a minimum, the following automatic measurements shall be made and recorded during the drilling operation:

a. auger rotation rate (in rpm);
b. depth of the auger injection point;

As a minimum, the following automatic measurements shall be made and recorded during the grouting operation:

a. volume of grout or grout pumped within an accuracy of ± 3%;

b. maximum and minimum grout pressure;
c. auger rotation rate (if rotated); and
d. depth of injection point.

Calibration shall be made on all measuring and recording equipment at the beginning of the project that will demonstrate that the values indicated by the measuring and recording equipment are within three percent (3%) of the values measured. Calibrations shall be performed in accordance with the equipment manufacturer's specifications. All measuring and recording equipment shall also be recalibrated when the Engineer suspects that the drilling and grouting performance has changed.

3-5. DRILLING. Heavy concentrated loads from the installation equipment shall be distributed to prevent compressing or shearing of the soil in the area near the top of the piles. Piles disturbed after installation shall be repaired or replaced at no additional cost to the Owner. After pile installation, a survey point shall be installed in the top of each test pile, load test reaction pile, and production pile as specified in paragraph of this specification titled, "Pile Locations".

Drilling of a pile shall begin only after an adequate amount of grout is available at the jobsite to complete the pile. The discharge port in the bottom of the auger shall be closed with a suitable plug while the auger is being advanced into the ground.

The auger shall be advanced into the ground at a continuous rate and at a rotation rate that prevents excess soil from being removed from the ground and transported to the ground surface. The penetration rate of the auger shall be maintained such that the auger advances a depth equal to or greater than the pitch of the auger for each 1.5 to 2 revolutions. The same drilling rate used to install the test pile(s) shall be used to install the production piles.

3-5.01. Obstructions. If auger refusal occurs above the approved design pile tip elevation, the pile shall be completed and the pile installation data submitted to the Engineer for review. Refusal is defined as a rate of auger penetration of less than 1 foot per minute.

3-6. GROUTING. The placement of grout shall begin within five (5) minutes after the auger has achieved the planned depth. Grout shall be pumped through the hollow-stem auger with sufficient pressure (as measured at the top of the auger) as the auger is withdrawn to completely form the pile and fill any soft or porous zones surrounding the pile.
At the start of grout pumping, the auger shall be raised from 6 to 12 inches to facilitate removal of the plug in the discharge port. After the grout pressure builds up sufficiently, the auger shall be re-drilled to at least the previously established tip elevation.

The grout shall be supplied to the pile at a rate during auger withdrawal that ensures that a continuous monolithic shaft of at least the full specified cross-section is formed, while maintaining the minimum grout factor of 1.2: one hundred and twenty percent

(120%) of the theoretical grout volume. After grout is flowing at the ground surface from the auger flights, the rate of grout injection and auger withdrawal shall be coordinated so that there is a constant grout flow at the surface. Satisfactory coordination of the auger withdrawal rate with pumping shall be verified with the pile installation recorder to maintain the minimum grout factor of 1.2. Augers shall be withdrawn at a smooth steady rate while continuously pumping. If rotation of the auger occurs during auger extraction, it shall be positive, i.e., in the same direction as drilling.

The volume of grout placed as a function of depth shall be measured and recorded at intervals not exceeding 2 ft using the pile installation recorder. The grout factor (ratio of grout volume placed to theoretical volume) for each production piles shall be within +/- 7.5 percent of that calculated for the test pile. In no case shall the target grout volume be less than 115 percent. Inadequate volume pumped over a depth interval of 5 ft is a basis for rejection of the pile. Rejected piles shall be re-drilled. If placement of grout is interrupted for any reason, such as equipment failure, the pile shall be re-drilled. The spoil that accumulates around the auger during injection of the grout shall be promptly cleared away. To prevent distortion of the top of the pile, the auger shall be extracted completely from the ground before moving the drill rig mast or the crane leads.

Drilling and pressure grouting within a radius of six (6) pile diameters of completed piles shall not be performed until the CFA pile Subcontractor that demonstrate that the grout in those piles is fully set, and damage to completed piles is prevented. If grout drop occurs in a previously cast adjacent pile due to soil mining, the pile shall be abandoned and additional piles installed at no additional cost to Owner at locations determined by the Engineer. The Contractor shall be required to use a longer delay time before adjacent pile construction.

After completion of grouting, the tops of piles shall be made square with the pile axis at the indicated cut off elevation. Earth clods and other foreign material shall be removed from the upper three (3) feet of the pile by using a screen type dipping device. The top of each pile shall be protected from contamination from earth clods or other debris by using a light gage sheet metal sleeve or other device extending a minimum of one (1) foot above and below the ground surface acceptable to the Engineer.

Upon removal of the auger, the required steel reinforcing shall be placed while the grout is still fluid.

3-6.01. Cold Weather Grouting. Except as modified herein, cold weather grouting shall comply with ACI 306. Unless the outdoor temperature (in shade) is at least 40ºF and rising, water and/or aggregates shall be heated so that the temperature of the grout, when placed, is not less than 55ºF. Provisions shall be made for maintaining the grout at a minimum temperature of not less than 50ºF for a period of at least 5 days. Sudden cooling of grout shall not be permitted.

3-6.02. Hot Weather Grouting. Except as modified herein, hot weather grouting shall comply with ACI 305. At air temperatures of 90ºF or above, grout shall be kept as cool as possible during placement and curing. The temperature of the grout when placed in the work shall not exceed 90ºF.

3-6.03. Grout Settlement. The level of each grout in a shift shall be checked at the end of the shift. If the level of grout has settled, the pile shall be filled with grout and rodded with a 1/2 inch diameter rod to a minimum depth equal to twice the height filled.

3-7. EXCAVATED MATERIALS. Excess grout and excavated materials shall be removed from the construction site and disposed of in accordance with the Excavation and Fill for Structures section.

3-8. REINFORCEMENTS. Cages of reinforcing steel shall be assembled as indicated on the working drawings. Reinforcing cages shall be fabricated so that lifting and handling does not cause permanent distortion or racking. Wire ties shall attach the longitudinal bars at the contact with every tie or spiral. The reinforcing steel shall be free of oil, soil, excessive rust or other deleterious material.

The reinforcing steel cage and center bar shall be centered in the excavation by means of plastic or grout spacers (centering guides) placed at sufficient intervals to keep the cage centered and provide the proper alignment and minimize disturbance to the soil. Spacers shall be placed at maximum of 10 feet intervals along the cage and at a minimum of 3 uniformly spaced intervals around the cage. Metallic spacers shall not be permitted, except metal spider type centralizers are permissible for the center bar. The spacers on center bars shall be placed at maximum of 20 feet centers. Centralizer types and spacing shall be acceptable to the Engineer.

The reinforcing steel shall be free of any permanent distortion, such as bars bent by improper pickup. The reinforcing steel shall not be spliced except at locations that are shown on the plans. If a pile is required by the Engineer to be lengthened after the steel has been cut and cages have been assembled, the schedule of reinforcing steel (both longitudinal and lateral) shall be extended to the required depth by splicing. Splices should be as close to the bottom of the reinforcing cage as possible. Splicing by welding will not be permitted.

Reinforcing steel shall be placed by lowering the steel into the grout column while it is in a fluid state after screening the grout. The steel may be lowered into the grout by gravity or pushed gently into position by hand. The reinforcing steel shall not be vibrated, driven, or otherwise guided into position by mechanical means.

The reinforcing steel shall be held in position at the ground surface within the fluid grout column by supports appropriate for the reinforcement used, which shall remain in place until the grout reaches its initial set, or 24 hours, whichever is longer.

3-09. PILE LOCATIONS. At completion of each pile, the Contractor shall install a survey point at the top center of each test pile, load test reaction pile, and production pile before the grout has set. The survey point shall be acceptable to the Engineer. Within 24 hours of initial set of the grout, the location and elevation of the survey point shall be determined by a surveyor licensed in Georgia and retained by Contractor. The location and elevations shall be recorded on forms acceptable to the Engineer. The forms shall include as a minimum, the pile identification number and the date and time of the survey. The form shall be submitted to the Engineer within 5 days of completion of all piles. After final subgrade preparation and prior to installation of the foundation mat reinforcing steel, the location and elevation of the piles shall be determined again by the Contractor and recorded on the form that contains the initial survey point locations and elevations for each pile.

Submit as-built pile location plans sealed by The Contractor's professional land surveyor. Plans shall include structure grid lines matching the numbering system on the Contract Drawings and be oriented with the north arrow matching the Drawing orientation. As-built survey plans shall include the pile as built plan location dimensioned as deviations from the design locations. Dimensions shall be orthogonal to the structure grid lines. As-built plans shall also provide the as-built top of pile elevation using the project datum. Out-of-tolerance piles shall be clearly listed in the submittal cover letter. Any piles installed outside the specified tolerance shall be replaced with additional piles as determined by the Engineer at no additional cost to Owner. The Engineer may request that that Contractor survey pile locations again prior to foundation grout placement if it is suspected that pile disturbance has occurred during placement of the reinforcing steel.

3-10. CURING. After the grout and reinforcing are placed, each pile shall be covered and cured in accordance with the Cast-in-Place Concrete section.

3-11. FIELD QUALITY CONTROL.

3-11.01. Grout Testing. Field control tests, including making compression test cylinders or grout cubes shall be performed by the Owner's independent testing laboratory. A minimum of 6 cylinders or cubes shall be made for each 50 cubic yards of grout placed. The Contractor shall provide all facilities and the services of one or more employees as necessary to assist with the field control testing activities. Tests required during the progress of the work shall be made at the expense of the Owner.

All testing and inspection by the Engineer and independent testing laboratory is for the sole benefit of the Owner and does not relieve the Contractor of the responsibility for providing quality control measures to ensure that the work strictly complies with the Contract Documents.

End of Section

Section 02371

PILE TESTING

PART 1 - GENERAL

1-1. SCOPE. This section covers load testing of continuous flight auger (CFA) piles including all materials, equipment, design, and labor. Installation of the test piles and reaction piles (or reaction anchors), and monitoring of the pile installation, shall be as specified in the Continuous Flight Auger Piles section. The piles installed for pre-production testing including reaction piles shall include the same equipment, installation methods, monitoring, testing, and inspection, as used for the production piles. The test pile(s) and reaction piles shall not be used as production piles.

1-2. PURPOSE OF TESTING PROGRAM. The purpose of the testing program is to establish for the CFA piles:

1. Target drilling penetration rates for the subsurface materials.
2. Pressure/volume relations for placement of grout.
3. Target values for torque and downward thrust.
4. Mix design parameters such as grout flow and necessary admixtures.

1-3. QUALITY CONTROL. The pile Subcontractor shall assign a qualified engineer registered in Georgia who shall serve as load test engineer and be in responsible charge of review of load test arrangement, monitoring the load tests and writing the load test report. The load test report shall be signed and sealed by the load test engineer. The load test engineer shall be either an employee of the pile Subcontractor or Contractor or an employee of an independent firm retained by the pile Subcontractor or Contractor. The load test engineer's responsibilities shall include:

a. Review drawings of load test setup drawings prepared by Pile Subcontractor prior to submission of load testing shop drawings by the Contractor.

c. Review of the installed load test setup prior to performance of load test.

e. Interpretation of test results and preparation of the load test report.

1-4. EXPERIENCE REQUIREMENTS.

1-4.01. Contractor's or Pile Subcontractor's Load test Engineer. The professional engineer employed by the pile Contractor or Subcontractor or retained by the Contractor or CFA pile Subcontractor to perform the duties of the load test engineer shall have experience in the testing and monitoring of pile load test.

1-5. SUBMITTALS. The Contractor shall submit as a minimum to Engineer in accordance with the submittals section:

a. Load Test Engineer's Experience. Qualifications of load test engineer shall include previous experience with static load testing of piles.

Test Pile Location. Proposed test pile location.

Load Test Setup. Detailed description of the load test setup, including description of the setup for measuring pile head movement, including sketches or drawings to illustrate the description.

Certification of Load Frame. Signed and sealed certification from structural engineer registered in the state of Georgia that load frame is designed for the specified test load.

Load Test Equipment. Testing and measuring equipment used in the load test, including jack, pressure gauge, and load cell calibrations.

Load Test Log Form. Form used to record loading sequence and load test movement.

Reports. Load test records and report.

PART 2 – PRODUCTS – Not used.

PART 3 - EXECUTION

3-1. LOAD TESTING. The objective of the pile testing program is to verify the design of production piles indicated on the Drawings. The axial compression load test shall be performed and load test results reported in accordance with ASTM D1143, except as modified or supplemented by this specification. Load testing shall consist of a minimum of one axial compression load test. The Contractor shall notify the Engineer one week prior to test pile installation and one week prior to performing the load test.

All load tests shall be performed on the test piles prior to installing any production piles, subject to acceptance by the Engineer.
3-1.01. Test Pile Location. The proposed test pile location shall be selected by Contractor and submitted to the Engineer. The test pile and reaction piles shall be installed at the same cutoff elevation as the production piles.

3-1.02. Test Pile Installation. If the pile installation method or equipment is changed after the load tests, another sacrificial pile shall be installed and load tested at the Contractor's expense. Installation of production pile shall not begin until the load test

report has been reviewed and approved by the Engineer.

A minimum of four reaction piles shall be provided and shall be located at least 8 feet clear distance from the test piles and shall be installed in a manner which prevents ground loss adjacent to or below the test pile. Test piles and reaction piles shall be installed with the necessary capacity to develop the apparatus used to apply the pile test loads.

No load test shall be conducted until the grout in the test pile has reached or exceeded the 7 day compressive strength specified in the Continuous Flight Auger Piles section.

3-1.03. Apparatus for Applying Loads. The capacity of the loading apparatus shall be sufficient to operate under the anticipated loading without incurring damage or interrupting the load test but shall not be less than the specified jack capacity. If the apparatus is damaged or the test interrupted, another load test shall be conducted at no additional cost to the Owner.

The pistons of the hydraulic jacks shall have sufficient strokes to accommodate the anticipated load frame deflections and test pile movements. The pressure gauge shall be certified for accuracy by an independent testing laboratory within 6 months of the load test date. The applied loads shall be verified and recorded by a calibrated load cell certified for accuracy of at least 2 percent of the applied load by an independent laboratory within 6 months of the load test date. Copies of the certifications shall be submitted to the Engineer.

The load test shall be set up to ensure the center of the jack is aligned axially with the center of the pile.

3-1.04. Apparatus for Measuring Movement. Measurement of pile head movement shall be performed in accordance with the applicable ASTM D1143, except as modified in this specification. The primary measurement system for pile head movement shall be dial indicators. A minimum of three dial indicators shall be used and shall be spaced evenly around the perimeter of the pile. The dial indicators shall be mounted on reference beams. Reference beams shall be firmly supported, with supports located at least 8 feet clear distance from test pile and reaction piles. The secondary movement measurement system shall consist of a piano wire and scale, or other system acceptable to the Engineer.

3-1.05. Load Test Setup. Sufficient plans, sections, details, and notes shall be included to provide instructions to workers erecting the apparatus that applies the load to test pile and the apparatus used for measuring pile head movement. As a minimum the drawings prepared for the load test setup shall include:

a. Dimensional plan indicating location of test pile, load frame, and reaction piles. Included on the plan shall be the location of reference beams and supports.

b. Elevation and sections depicting load frame, test pile, reaction piles, and reference beams shown relative to the existing floor slab.
c. Partial Plan and sections or details indicating how dial indicators will be mounted.
d. Sections and/or details indicating how jack load will be transferred to test pile bearing plate.

3-1.06. Loading Test Pile. Load increments shall be based on the design load capacity for the pile, and the full test load shall be at least 2 times the design load unless failure occurs first.

This pile load testing shall be in general conformance with applicable ASTM D1143; Procedure A: Quick Test except the maximum load (twice the design load) shall be held for at least 2 hours. After completion of the ASTM Quick Test procedure, load the pile until failure occurs in accordance with loading sequence and procedure of ASTM D1143, Procedure C: Loading in Excess of the Maintained Load Test.

The load increments shall be applied and the increment recorded in accordance with applicable STM D1143.

3-2. LOAD TEST REPORT.

3-3 PAYMENT. The base bid for the test piles shall be on the number of pile load test specified herein. Payment for additional axial compressive load test and axial tensile load tests shall be in accordance with the adjustment unit prices provided in the Bid Form.

End of Section

Section 02512

ASPHALT PAVING

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of labor, materials and equipment for the construction of asphaltic concrete base or binding course, bituminous tack coat, and asphaltic concrete surface or wearing course for the roadway, driveways and parking area as indicated on the Drawings.

Subgrade preparation shall be as indicated in the Excavation and Fill for Structures section, unless otherwise specified in the governing standards or herein.

Asphaltic concrete paving shall be constructed to the lines, grades, and cross sections indicated on the drawings. Type of construction shall be as indicated on the Drawings and as specified herein.

Concrete pavements are covered in the drawings and the requirements for placing concrete are covered in the Concrete sections.

1-2. GENERAL.

1-2.01. Governing Standards. Except as otherwise specified or indicated, materials, equipment, details, and construction methods shall comply with the applicable Georgia DOT provisions.

1-2.02. Coordination. Contractor shall coordinate the construction of asphaltic concrete paving with the excavation, the construction of concrete curb and gutters and other construction.

1-3. SUBMITTALS. All submittals of design mix reports including design mix test results and other data, shall be in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. MATERIALS. The sources of materials shall be acceptable to Engineer. Except as modified herein, materials shall conform to the requirements of the governing standards. Delivery tickets for all materials delivered to the site shall be submitted to Engineer at the end of each day during the progress of the work.

Asphaltic concrete materials shall be in accordance with applicable requirements of the Georgia Department of Transportation, City of Atlanta and DeKalb County for roadway design and construction.

2-2. DESIGN MIXES. A design mix for the asphalt base course and for the surface course, based upon the aggregates to be furnished, shall be determined by an independent testing laboratory at the expense of Contractor and shall be submitted to Engineer for review.

The design mixes upon acceptance by Engineer, shall be the basis for the mixes to be used in asphaltic concrete pavement construction. The proposed design mix data submitted for review shall include at least the following:

Marshall stability, all mixtures

Density

Number of compaction blows

Flow, all mixtures

Percent air voids: (laboratory specimen)
Base
Surface
Percent Voids in the following mineral aggregate:
3/4 inch max size
5/8 inch max size
3/8 inch max size

PART 3 - EXECUTION

3-1. EQUIPMENT. Equipment and facilities for storage, measuring, mixing, heating, transporting, spreading, compacting, and other operations shall be in accordance with the applicable requirements of the governing standards. Improved or modernized equipment which will produce results equal in quality to those which would result from

the specified equipment will be considered for use. All equipment and facilities shall be acceptable to Engineer.

3-2. SUBGRADE PREPARATION. As a minimum, the top 6 inchesof the subgrade shall be compacted to 98 percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing materials are placed. All subgrade and surfacing shall be sloped toward drains or outer edges.

3-3. PAVEMENTS. Unless otherwise specified, the new pavements to be constructed shall consist of an asphaltic concrete base course and an asphaltic concrete surface course, each of the thickness indicated on the Drawings. Asphaltic concrete base course shall be placed in compacted lifts no greater than 4 inches. Asphaltic concrete surface course shall be placed in compacted lifts no greater than 2 inches.

Grade control shall be maintained by Contractor by means of automatic screed controls on the paving machine and by use of erected and mobile string lines as applicable. The use of the automatically controlled paver may be waived by Engineer on irregular sections. Finished surfaces shall conform to the lines and grades indicated on the Drawings.

Asphaltic concrete pavements shall be constructed on previously prepared subgrades in accordance with the sections, in compliance with the governing standards.

Asphalt mixtures may be spread and finished by hand methods only where machine methods are impractical as determined by Engineer. Hand placed mixtures shall not be cast or otherwise manipulated in such manner that segregation occurs.

Minimum temperatures under which asphaltic concrete pavements may be constructed shall be as stipulated in the governing standards.

3-4. REPAIR OF DEFECTS. Contractor shall remove and replace defective areas by cutting to the full depth of the course. Cuts shall be made perpendicular and parallel to the direction of traffic with edges vertical.

A tack coat shall be applied to all exposed surfaces. The area shall be filled with fresh hot asphaltic concrete mix in lifts of the same depths as the adjacent area, then compacted by rolling to specified surface density and smoothness.

3-5. CLEANING. After completion of paving operation, all areas shall be cleaned

of excess spilled asphalt materials to the satisfaction of Engineer.

3-6. PROTECTION. In addition to the requirements for protection stipulated in the governing standards, Contractor shall protect all adjacent concrete and masonry so that no damage will occur as the result of subsequent construction operations. All damage or discoloration shall be repaired to the satisfaction of Engineer before final acceptance by Owner.
Special care shall be taken to prevent tack or other asphalt materials from spraying or splashing. Adjacent construction shall be protected by covering with suitable fabric or paper.

End of Section

Section 02522

CONCRETE SIDEWALK, CURB, AND GUTTER

PART 1 - GENERAL

1-1. SCOPE. This section covers the construction of concrete sidewalks, curb and gutter. This section also covers the reconstruction of concrete sidewalks, curb, and gutter.

Subgrade preparation shall be as indicated in the Excavation and Fill for Structures section, unless otherwise specified in the governing standards or herein.

1-2. GENERAL. All existing sidewalks, and curb and gutters disturbed or damaged during construction of new work, or indicated on the Drawings to be demolished and replaced shall be reconstructed to the lines, grades, and cross sections indicated on the Drawings. Damaged curbs, sidewalks and/or gutters shall be to restored to their original locations, cross sections, and style unless indicated otherwise on the Drawings.

Contractor shall be responsible to remove, construct, reconstruct, and adjust as necessary all existing or new manhole tops, curb and gutter, and area drainage structures to match new grades as needed.

1-2.01. Governing Standards. Except as otherwise specified or indicated on the Drawings, materials, equipment, details, and construction methods shall comply with the applicable Georgia DOT standards.

PART 2 - PRODUCTS

2-1. MATERIALS. The sources of materials shall be acceptable to Engineer. Except as otherwise modified herein, materials shall conform to the requirements of the governing standards.

Concrete materials shall be as follows:

Sidewalks

Concrete designation.	Class A3
Portland cement designation.	Type I or II
Aggregate designation.	Coarse and Fine

Curbs and Gutters.	
Concrete designation.	Class A3
Portland cement designation.	Type I or II
Aggregate designation.	Coarse and Fine
Reinforcing steel grade.	ASTM A706 or A615

PART 3 - EXECUTION

3-1. SUBGRADE PREPARATION. As a minimum, the top 6 inches [150 mm] of the subgrade shall be compacted to a 95 percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing, curb and gutter, or sidewalk materials are placed. All subgrade and surfacing shall be sloped as indicated on the Drawings, and as needed to achieve a uniform slope between new and existing surfaces. Sidewalks shall slope toward one edge.

3-2. CONCRETE SIDEWALKS. Concrete shall be placed, vibrated, and finished as described in the governing standards.

One-half inch [12.7 mm] expansion joints shall be provided where sidewalks abut a curb, structure, existing sidewalk, at changes in directions, and at intervals of not more than 40 feet [12 m]. Expansion joints shall be filled to within 3/4 inch [19 mm] of the surface with bituminous expansion joint material, and then filled flush to the surface with self-leveling caulking in accordance with the Joint sealant section. The joint sealing compound shall be finished slightly concave, and shall not be allowed to overflow the joint.

Concrete sidewalks shall be screeded to the proper elevation and contour. All aggregates shall be completely embedded in mortar. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface. A second floating at the time of initial set shall follow initial floating.

Floated surfaces shall be given a light broom finish, using a horsehair broom, to provide a nonslip surface. Brooming shall be at right angles to the length of the curb, walk, or gutter.

Sidewalks shall be edged using a 3 to 4 inch [75 to 100 mm] wide edging tool with a 1/8 inch [3 mm] corner radius. Edger lap marks at corners of each slab shall be carefully removed. False joints shall be provided at right angles to the length of the walk, using a grooving tool with 1/8 inch [3 mm] radius and a depth of 1.2 inch [13mm). The finished edge on each side of the joint shall be the same width as the edging tool used. False joints shall divide each sidewalk into square sections.

The finished surface of all sidewalks shall be neat in appearance, shall be sloped to drain, and shall not pond water.

The finished concrete shall be cured and protected as stipulated in the governing standards.

3-3. CONCRETE CURB AND GUTTER. New concrete curb and gutter shall be as indicated on the Drawings and specified herein. Replacement concrete curb and gutter shall match the existing curb and gutter. Unless otherwise authorized by Engineer, adjacent and enclosed curbs, drainage structures, and gutters shall be placed before placement of pavement sections.

Expansion and contraction joints shall be formed at right angles to the alignment of the curb and/or gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards. One half inch [12.7 mm] wide expansion joints shall be placed full depth using a pre-molded expansion joint material, cut to the configuration of the full size of the section, being secured so that they are not moved by depositing, compacting or finishing the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch [3 mm] radius.

Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet [14 m].

Contraction joints shall be a minimum of 3 inches [76 mm] deep on all sides, shall be spaced at approximately 15 foot [5 m] intervals, and shall be formed by a 1/8 inch [3 mm] thick steel template, cut to the configuration of the section. These templates shall be secured so they are not moved by depositing, compacting or finishing the concrete.

Unless otherwise indicated on the drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch [10 mm].

All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

3-3.01. Forms. Forms shall be in conformance with the governing standards. All forms shall be in good condition, with not more than 1/8 inch [3 mm] variation in horizontal and vertical alignment for each 10 feet [3 m] in length. Side forms shall have a depth at least equal to the edge thickness of the concrete being formed. The forms shall be set true to line and grade and shall be adequately supported to stay in position while depositing and consolidating the concrete. Forms shall be designed and constructed so as to permit their removal without damage to the concrete.

3-3.02. Joints. Expansion and contraction joints shall be formed at right angles to the alignment of the curb and gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards.

Expansion Joints. One half inch [12.7 mm] wide expansion joints shall be placed full depth using a pre-molded expansion joint material, cut to the configuration of the full size of the Curb and Gutter section, being secured so that they are not moved by depositing and compacting the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch [3 mm] radius.

Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet [14 m].

Contraction Joints. Contraction joints shall be a minimum of 3 inches [76 mm] deep on all sides, shall be spaced at approximately 15 foot [5 m] intervals, and shall be formed by a 1/8 inch [3 mm] thick steel template, cut to the configuration of the Curb section. These templates shall be secured so that they are not moved by depositing and compacting the concrete.

Unless otherwise indicated on the Drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch [10 mm].

All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

3-3.03. Finishing. Curb and gutter shall be finished to the shape indicated on the Drawings. After the forms have been removed, all exposed edges shall be rounded, using an edging tool with a 1/8 inch [3 mm] corner radius. Exposed surfaces shall be float finished and given a light broom finish applied at right angles to the curb at the time

of initial set, using a horsehair broom. Mortar or dryer shall not be used to remove imperfections. In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The finished curb shall have a true surface, free from sags, twists, or warps; shall have a uniform appearance; and shall be true to the original lines, grades, and configurations indicated on the Drawings.

3-4. PROTECTION. In addition to the requirements for protection set forth in the governing standards, Contractor shall protect all adjacent concrete and masonry so that no damage will occur as the result of subsequent construction operations. All damage or discoloration shall be repaired to the satisfaction of Engineer before final acceptance by Owner.

Special care shall be taken to prevent bituminous materials from spraying or splashing. Adjacent construction shall be protected by covering with suitable fabric or paper.

End of Section

SECTION 02535

GRAVITY FLOW SANITARY SEWERS

PART 1 - GENERAL

1-1. SCOPE.

The work covered under this section includes furnishing all labor, equipment, and materials required to furnish, install, test, and inspect gravity flow sanitary sewers as shown on the Plans and specified in this section.

Unless directed otherwise in writing by the Engineer, the Contractor shall use only the pipe sizes and materials specifically designated on the Plans.

1-2. SUBMITTALS.

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

The Contractor shall submit proposed methods, equipment, materials, and sequence of operations for sewer construction. The Contractor shall plan operations to minimize disruption of utilities and to occupied facilities on adjacent property.

The Contractor shall submit manufacturers' instructions indicating special procedures required to install products specified.

The Contractor shall submit certifications that products meet or exceed the requirements specified in these Specifications.

The Contractor shall submit a set of plans (modified to show as-built conditions.)
The Contractor shall submit test reports.

1-3. QUALITY ASSURANCE.

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

AASHTO T180 - Standard Specification For Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457-mm (180-in) Drop.

ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.

ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

ASTM C700 – Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.

ASTM D1557 - Standard Test Method for Laboratory, Compaction Characteristics of Soils Using Modified Proctor Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)

ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

American Water Works Association (AWWA), Latest Revisions.

The Contractor shall provide the Engineer with the product manufacturers' written certification that all products furnished comply with all applicable provisions of these Specifications. Except as may be modified herein, all materials used in the manufacture of pipe, linings, manholes, and castings shall be new and shall be tested in accordance with the referenced standards, as applicable. The Contractor shall be responsible for performing and paying for sampling and testing as necessary for the certifications. The Engineer shall have the right to witness testing of the materials, provided that the Contractor's schedule is not delayed for the convenience of the Engineer.

The sewer pipe shall be tested and inspected at the place of manufacture for all requirements of the latest applicable ASTM standards, and certified copies of the test report covering each shipment shall be submitted to the Engineer prior to laying. After delivery, pipe and fittings will be subject to inspection by and approval of the Engineer. No broken, cracked, misshaped, or otherwise damaged or unsatisfactory pipe, fittings, or damaged concrete lining shall be used.

Each pipe shall be clearly marked as required by the governing ASTM standard specifications to show pipe class, date of manufacture, date coated, type of coating, and manufacturer's trademark.

All pipe, accessories, and specials shall be new material.

If directed by the Engineer, each pipe manufacturer shall furnish the services of a competent factory representative to supervise and/or inspect the installation of pipe. This service will be furnished for a minimum of five (5) days during initial pipe installation.
All pipes shall be subject to inspection by the Engineer at the place of manufacture. The Contractor shall notify the Engineer in writing of the manufacturing start date at least fourteen (14) days prior to the start of manufacturing. The Contractor shall be responsible for all inspection costs.

All pipes shall be inspected upon arrival. If any portion of a shipment is found to be defective in diameter or thickness, the entire shipment shall be rejected and removed from the site of the Work at no cost to the City. Each section of pipe shall again be thoroughly inspected immediately prior to lowering it into the trench to insure that the interior is clean and to check for joint scratches, chipped ends, and imperfect gasket seats. Any defective pipe or fitting discovered after the pipe is laid shall be removed and replaced with a satisfactory pipe or fitting without additional charge.

1-4. PRODUCT DELIVERY, STORAGE, AND HANDLING.
The Contractor shall inspect pipe materials and fittings upon arrival at the site of the Work.

The Contractor shall handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear, or free fall. The Contractor shall not drag pipe and fittings along the ground. The Contractor shall not roll pipe unrestrained from delivery trucks.

The Contractor shall use mechanical means to move or handle pipe. The Contractor shall employ acceptable clamps, rope, or slings around the outside barrel of pipe and fittings.

PART 2 - PRODUCTS

2-1. PIPE MATERIALS.
All materials used in the construction of gravity flow sanitary sewers shall be new, unused, and shall be of the sizes indicated on the Plans**.**
All materials shall be in strict compliance with the required standards and specifications including ASTM, ANSI, and AWWA.

At points of the sewer where a change in pipe classification is shown on the Plans, the Contractor may begin at the next joint of pipe rather than cutting the pipe and constructing a collar unless there is a change in horizontal or vertical alignment. In the event the pipe is cut, there shall be no torch cutting, only saw cutting will be allowed.

Ductile Iron Pipe and fittings shall conform to the requirements of Section 02537 – Ductile Iron Sanitary Sewer Pipe and Fittings.

2-2. TRANSITION COUPLINGS.
Transition joints between sewer pipes of different materials shall be accomplished by the use of City of Atlanta standard concrete collar walls. Use of any other material shall require approval by the Engineer.

2-3. APPURTENANCES.
Manholes shall conform to the requirements of Section 02607 – Manholes, Junction Boxes, Catch Basins and Inlets.

2-4. BACKFILL.
Pipe backfill materials shall conform to the requirements of Section 02200 - Excavation and Backfill for Structures, and Section 02202 - Trenching and Trench Backfilling.

PART 3 - EXECUTION

3-1. GENERAL.
The Contractor shall control traffic in accordance with the requirements of Section 01550 - Traffic Regulation.

All activities shall be performed in accordance with the manufacturers' recommendations and regulations established by OSHA. Particular attention shall be drawn to those safety requirements involving working with scaffolding and entering confined spaces.

The Contractor shall identify the locations of all existing underground utilities prior to commencing excavation activities. The Contractor shall consult with utility companies to verify the locations of existing underground utilities.

The Contractor shall notify the agency or company owning any utility line which is damaged, broken, or disturbed. The Contractor shall obtain approval from the Engineer and the utility owner prior to performing any temporary or permanent repairs, or relocation of utilities.

The Contractor shall install and operate a dewatering system in accordance with the requirements of Section 02140 - Dewatering.

Where wastewater flow diversion is required for the performance of the Work, the Contractor shall provide wastewater flow diversion in accordance with the requirements of Section 02600 - Wastewater Flow Control.

3-2. PIPE LAYING.
The Contractor shall install the pipe in accordance with the pipe manufacturer's recommendations and as specified in this section.

The Contractor is responsible for accurately placing pipe to the exact line and grade shown on the Plans. The control of vertical and horizontal alignments shall be accomplished by the use of a laser beam instrument. When a laser is used, the elevation and alignment of the pipe shall be checked by transit and level rod every fifty (50) feet for smaller pipe and every joint for pipe forty eight (48) inches and larger.

Other approved methods of controlling vertical and horizontal alignments may be used if specifically authorized by the Engineer. The pipe section may be adjusted by the use of "come-along" of approved design and anchorage. The practice of bumping or snatching (with backhoe or crane, etc.) used to adjust pipe after placement in the trench, will not be permitted. The Contractor shall furnish all labor and materials necessary for controlling the line and grade.

Each piece of pipe and special fitting shall be carefully inspected before it is placed, and no defective pipe shall be laid in the trench. Before a sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill.

Trench bottoms found to be unsuitable for foundations shall be undercut and brought to exact line and grade with pipe cushion, concrete cradles, foundation backfill, or as directed by the Engineer.

For bell and spigot pipe, bell holes shall be of sufficient size to allow ample room for properly making the pipe joints. Bell holes shall be cut no more than five (5) joints ahead of pipe laying. The bottom of the trench between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden offsets or inequalities in the flow line.

Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. The Contractor shall not open up at anytime more trench than his available pumping facilities are able to dewater. Movement of water that would tend to erode or affect the trench walls will not be allowed.

As the work progresses, the interior of all pipe in place shall be thoroughly cleaned. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior.

Backfilling of trenches shall be started immediately after the pipe is in place and the joints completed, inspected, and approved by the Engineer.

At times when work is not in progress, open ends of pipe and fittings shall be securely closed, to the satisfaction of the Engineer, so that trench water, earth or other substances will not enter the pipe or fittings.

3-3. JOINT CONSTRUCTION.

For bell and spigot pipe, the inside of all bells and the outside of all spigots shall be wiped to remove all dirt, water, or other foreign matter so that their surfaces are clean and dry when the pipes are joined.

Rubber ring gasket joints for sewer pipe shall be installed according to the pipe manufacturer's specifications and recommendations. Extreme care shall be used in joining large diameter pipe to avoid damaging the rubber ring or displacing it from the proper operating position.

Joints on ductile iron pipe sewers shall be compression joints, except where mechanical or flanged joints are called for on the Plans, and shall be installed according to the pipe manufacturers' specifications and recommendations.

After the joints have been completed, they shall be inspected by the Engineer before they are covered. Any leaks or defects discovered at anytime after completion of the Work shall be repaired immediately. Testing of gravity sewers shall be performed in accordance with the requirements of Section 02650 - Testing for Acceptance of Sanitary and Storm Sewers. All pipe in place shall be carefully protected from damage until the backfilling operations have been completed. Any pipe which has been disturbed after jointing shall be removed, the joint cleaned and remade and the pipe relaid at the Contractor's expense.

3-4. TEE CONNECTIONS.

Tee branches shall be installed in sanitary sewer lines at all points shown on the Plans or directed by the Engineer. If such branches are not to be used immediately, they shall be closed with approved stoppers and shall be physically restrained.

All existing sanitary service lines shall be disconnected from the existing combined sewer and reconnected to the new sanitary sewer.

Tees shall be installed in sanitary sewers so as to properly connect each existing house and to serve each vacant lot facing or abutting on the street or alley in which the sewer is being laid and at such other locations as may be designated by the Engineer. The exact location of each connection shall be recorded by the Contractor, on the record drawings, utilizing conventional GPS survey, before backfilling and said records delivered to the Engineer.

Tees shall be standard manufactured tees.

3-5. CONNECTING RISERS.

Where shown on the Plans, included in the Special Conditions, or directed by the Engineer, and where the depth of cut is over eight (8) feet or where the grade of a sanitary sewer is lower than necessary to drain abutting property, and at such other locations as may be designated by the Engineer, connecting risers shall be installed to connect each existing house and to serve each vacant lot facing or abutting on the street on which the sewer is being laid.

Connecting risers shall be sized in accordance with the plumbing code in effect at the time of construction but shall not be smaller in size than shown on the Plans. Risers shall be installed from a tee connection to the elevation needed to connect house services, the elevations shown on the Plans, or as directed by the Engineer. The tee connection shall be installed at the location shown on the Plans, and in accordance with the Detail Drawings. Open ends of connecting risers shall be closed with approved stoppers and be physically restrained. Backfilling shall be carefully done around risers using materials specified in Section 02200 - Excavation and Backfill for Structures, and compacted to the equivalent density of the surrounding undisturbed material.

3-6. HOUSE SEWERS AND MULTIPLE DWELLING SEWERS.

Stubouts for house service lines and multiple dwelling service lines shall be installed when stipulated in the Special Conditions or shown on the Plans. However, additional connections shall be installed by the Contractor when directed by the Engineer. House service lines for single dwelling units shall consist of six (6) inch diameter sewer pipes, and service lines for multiple dwelling units served by a single line shall consist of eight (8) inch diameter sewer pipes, constructed as specified in this section.

If the plumbing code in effect at the time of construction specifies larger pipe or if the existing house service line is larger than the specified diameters, then the larger pipe shall be installed. House service line stubouts for vacant lots shall be installed at the locations shown on the Plans or designated by the Engineer to provide a service line from the tee in the sewer. House service line stubouts shall be installed in accordance with the Detail Drawings. The open end of such stubouts shall be closed with approved stoppers and properly restrained.

Cleanouts shall be installed for each continuous run of one hundred (100) feet and at each change in horizontal or vertical direction. Cleanouts shall be constructed in accordance with the Detail Drawings. Cleanouts shall be plugged with approved stoppers. Stoppers shall be properly restrained.

Backfilling for service lines shall commence immediately upon acceptance by the Engineer. Backfill materials shall be as specified in Section 02200 - Excavation and Backfill for Structures, and shall be compacted to the equivalent density of the surrounding undisturbed material.

3-7. CONNECTING EXISTING SANITARY SEWERS TO NEW SANITARY SEWERS.

All existing separate sanitary sewers shall be connected to new separate sanitary sewers as shown on the Plans or as directed by the Engineer. Connections shall be made by the construction of a manhole or utilization of an existing manhole.

Connection of lateral collector sewers to large diameter trunk sewers shall be made at existing manholes or new manholes.

Connections to existing manholes shall be made by coring a hole in the wall of the existing manhole, installing a boot, inserting the same pipe material as the mainline being constructed, filling around same with non-shrinking grout and troweling the inside and outside surfaces of the joint to a neat finish.

Connections of existing separate sanitary sewers to new separate sanitary sewers shall be plugged, and shall remain plugged until final acceptance by the Engineer.

3-8. TOLERANCES.

3.08.01. Invert Elevations: The invert elevations shown on the Plans shall be for the invert at the centerline of the precast concrete manhole. Prior to setting the laser or other vertical alignment control system for the sewer upstream of the manhole, the other Contractor shall verify the elevation of the sewer installed at the manhole. Should the elevation differ from that shown on the Plans, the Contractor shall take the following corrective action:

1. If the sewer is laid at negative grade, the Contractor shall remove and reinstall the sewer at the correct grade at no additional cost to the City.
2. If the sewer is laid at a grade less than that shown on the Plans, thus reducing the sewer's capacity, the City may require the sewer to be removed and relaid at the correct grade at no additional cost to the City. As a minimum, the grade to the next upstream manhole shall be adjusted such that the next upstream manhole shall be set at the correct elevation.

3. If the sewer is laid at a grade greater than that shown on the City, and if the Contractor can show that there are no conflicts with upstream existing utilities or obstructions, the Contractor shall adjust the grade of the next upstream manhole such that the next upstream manhole shall be set at the correct elevation. If such an adjustment, in the Engineer's opinion, is substantial, the grade adjustment shall be spread over multiple sections of the sewer. If such an adjustment, in the City's opinion, significantly reduces the sewer's capacity, the City may require the Contractor to remove and relay that portion of the sewer laid at the improper grade.

3-9. PIPE PROTECTION.

Where foundation conditions are not satisfactory, as determined by the Engineer, the sewer pipe shall be protected with proper pipe protection as shown on the Plans or as directed by the Engineer.

Plain concrete ditch checks may be required by the Engineer on steep slopes and other locations to prevent erosion of the backfilled trench.

3-10. TESTING. All manholes shall be vacuum tested and all gravity flow sanitary sewer joints shall be pressure tested in accordance with the requirements of Section 2650, Testing for Acceptance of Sanitary and Storm Sewer. Testing shall be performed in the presence of the Engineer.

3-11. CLEANUP. After completing each section of the sewer line, the Contractor shall remove all debris and construction materials and equipment from the site of the Work; grade and smooth over the surface on both sides of the line; and leave the entire construction area in a clean, neat, and serviceable condition. The Contractor shall restore the site of the Work to the original or better condition.

Prior to requesting a final inspection, the Contractor shall remove and dispose of all shipping timbers, shipping bands, boxes, and other like debris brought to the site of the Work.

Any lawns, fences, drainage culverts, or property damaged by the sewer construction shall be repaired or replaced to equal or better condition than existing prior to commencement of the Work.
All shoulders, ditches, culverts, and other areas affected by the sewer construction shall be at the proper grades and smooth in appearance to provide positive drainage of the site of the Work.

All manhole covers shall be brought to grade, as shown on the Plans, or as directed by the Engineer.

End of Section

SECTION 02537

DUCTILE IRON SANITARY SEWER PIPE AND FITTINGS

PART 1 - GENERAL

1-1. SCOPE

This section includes Specifications for ductile iron sanitary sewer pipe and fittings for sanitary sewer installations as shown on the Plans and as specified in these Specifications.

The Contractor shall provide all services, labor, materials, and equipment for all installation of ductile iron sanitary sewer pipe and fittings and related operations necessary or convenient to the Contractor for furnishing a complete Work as shown on the Plans or specified in these Specifications.

1-1.01. Related Work Specified Elsewhere:

1. Section 01200 - Measurement and Payment
2. Section 02000 - Site Work
3. Section 02200 - Excavation and Backfill for Structures
4. Section 02202 - Trenching and Trench Backfilling
5. Section 02205 - Dewatering
6. Section 02535 - Gravity Flow Sanitary Sewers
7. Section 02600 - Wastewater Flow Control
8. Section 02650 - Testing for Acceptance of Sanitary and Storm Sewers

1-2. SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

The Contractor shall submit, for the Engineer's approval, descriptive details and shop drawings covering full details of pipe, fittings, joints and the assembly thereof, joint materials and details thereof, and full details and cuts of all castings to be incorporated into the Work.

The Contractor shall provide manufacturers' certifications that all ductile iron pipe and fittings meet the provisions of this section and meet the requirements of ANSI A21.51 (AWWA C151). Product certification shall include tensile and Charpy test results which shall be traceable to pipe numbers and testing periods. For pipe sizes thirty (30) inches and larger, hydrostatic test charts including pipe numbers for each test cycle shall be furnished as part of the certification test reports. Chemical analysis shall be furnished for each ladle of iron which will cover each pipe cast and must correlate with the mechanical test results. For pipe sizes thirty (30) inches and larger, complete traceability is required throughout the certification process and must be clearly legible

on each pipe at the point of installation. Hydrostatic test results for any size pipe shall be furnished to the Engineer.

The Contractor shall provide certifications that all pipe joints have been tested and meet the requirements of ANSI A21.11 (AWWA C151).

1-3. QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

ANSI A21.4 (AWWA C104) - Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings, for Water and Other Liquids.

ANSI A21.10 (AWWA C110) - Ductile Iron and Gray Iron Fittings, 3-in. through 48-in., for Water and Other Liquids.

ANSI A21.11 (AWWA C111) - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.

ANSI A21.15 (AWWA C115) - Flanged Ductile Iron Pipe with Threaded Flanges.

ANSI A21.50 (AWWA C150) - Thickness Design of Ductile Iron Pipe.

ANSI A21.51 (AWWA C151) - Ductile Iron Pipe, Centrifugally Cast for Water and Other Liquids.
ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.

ASTM D1248 - Polyethylene Plastics Molding and Extrusion Materials.

ASTM G62 - Test Methods for Holiday Detection in Pipeline Coatings.

AWWA C600 - Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.

SSPC-SP6 - Steel Structures Painting Council, Commercial Blast Cleaning.
The Contractor shall submit certification from the manufacturer, sealed and stamped by a Professional Engineer Registered in the State of Georgia who is not an employee of the manufacturer, that the pipe to be supplied under this Agreement will provide a one-hundred (100) year service life if manufactured and installed in accordance with the plans and specifications for this project.

1-4. MATERIAL TESTING

The attention of the Contractor is directed to the provisions of the Conditions of the Contract requiring the inspection and testing of materials to be incorporated into the Work.

Each pipe in the size range four (4) inches to twenty-four (24) inches shall receive a hydrostatic proof test of 500 psi for a minimum duration of fifteen (15) seconds. Each pipe in the size range thirty (30) inches and larger shall receive a hydrostatic test not less than seventy-five (75) percent of the specified minimum yield strength for the duration of the test. Each test cycle shall be recorded on a strip chart. Each test cycle for pipe thirty (30) inches and larger shall be marked by pipe number. Each pipe shall be inspected for leaks. Pipes which contain evidence of hydrostatic leak shall be scrapped. Repair welding of hydro-leaks is not permitted.

Tensile test specimens shall be cut longitudinally from the midsection of the pipe wall. These specimens shall be machined and tested at least every three (3) hours in accordance with the requirements of ASTM E8, and ASTM A370 where applicable, using the 0.2% offset method. Brinell hardness tests shall be performed at the same frequency as the tensile test and shall meet a maximum Brinell hardness of two-hundred and thirty (230). Pipe failing to meet the minimum requirements of these standards shall be rejected. Adjacent test samples shall be made available to the City's independent testing laboratory upon the City’s request.

Charpy impact samples shall be taken during each hour of production. Samples shall be selected to properly represent extremes of pipe diameters and wall thickness. Impact tests shall be conducted in accordance with the requirements of ASTM E23. Impact strengths on samples shall be eight (8) ft-lb minimum for tests conducted at seventy 70° ± 10 per ANSI A21.51 (AWWA C151). In addition, adjacent specimens shall be taken and made available to the City's laboratory for independent testing upon the City's request.

Each end of each pipe (each pipe socket and pipe spigot) shall be measured and shall conform to the standard dimensions of ANSI A21.51 (AWWA C151). In addition, each socket and spigot shall be inspected in a well lighted area for injurious defects which could affect joint performance. Such defects may be removed by cutting off pipe ends. Pipe with injurious defects in the bell must be scrapped.

The City or the City’s designated inspection agency shall have access to all areas of the pipe manufacturer’s plant during production, inspection, and shipping and shall have the opportunity to witness all tests associated with production and inspection of pipe and fittings for any given order. Reasonable facilities shall be provided for the City or the City’s designated inspection agency to facilitate their work while at the manufacturing facility. All production and quality assurance records shall be made available for review by the City or the City’s designated inspection agency upon request.

All testing work specified in this section shall be performed by the supplier. The manufacturer shall perform all tests in house as part of their quality assurance/quality control. Test results shall be submitted to the Engineer in accordance with the requirements of this section.

PART 2 - PRODUCTS

2-1. DUCTILE IRON PIPE

Ductile iron pipe shall be centrifugally cast, manufactured, and tested in accordance with the requirements of ASTM A746 and furnished in minimum eighteen (18) feet to twenty (20) feet lengths unless otherwise approved by the Engineer. Pipe class shall be Class 50 unless otherwise specified on the plans.

Joints for ductile iron pipe shall be push-on type such as Fastite, Tyton, or Super Bell-Tite or approved equal unless mechanical joints are specified elsewhere in these Specifications or approved by the Engineer. Joints shall be manufactured in accordance with the requirements of ANSI A21.11 (AWWA C111).

For ball and socket joints, the bell, ball, and retainer shall be ductile iron, Grade 70-50-05, conforming to the requirements of ANSI A21.11 (AWWA C111).

Joints for flanged pipe shall conform to the requirements of ANSI A21.11 (AWWA C111).

Restrained joints shall conform to the requirements of ANSI A21.10 (AWWA C110) unless otherwise approved by the Engineer.

Joints for “bell less” ductile iron MT Push Pipe or GS Push Pipe shall be sealed with O-ring rubber gaskets installed in an independent internal coupling or in a machined tongue and groove type joint. Joint shall be manufactured in accordance with the requirements of ANSI A21.11 (AWWA C111) and supplied in minimum four (4) foot lengths unless otherwise approved by the Engineer.

Ductile iron pipe shown on the drawings or otherwise specified of another class other than class 50 shall be marked by the manufacturer for ease of identification. Class 51 shall have 2 - 2inch yellow stripes, Class 53 shall have 3 - 2inch yellow stripes, etc.

2-2. FITTINGS

The Contractor shall use fittings of the same size and pressure rating as the pipe.

Unless otherwise specified elsewhere in these Specifications or approved by the Engineer, mechanical joint fittings shall be used for both push-on type and mechanical joint type pipe. Ductile iron fittings for push-on pipe shall be designed for the same working pressure, laying conditions, and cover as the pipe which is used.

Fittings manufactured for ductile iron pipe shall conform to the requirements of ANSI A21.10 (AWWA C110), unless not made in C110, and C153 will be approved.

2-3. COATINGS

All ductile iron pipe and fittings used in open cut installations shall have a double cement-mortar lining conforming to the requirements of ANSI A21.4 (AWWA C104) and a standard bituminous outer coating. In four (4) inches and six (6) inches sizes used in open cut installations, fittings may be supplied with bituminous or epoxy lining, in lieu of cement-mortar, and standard bituminous outer coatings. All ductile iron pipe and fittings used in trenchless installations shall have a polyethylene lining conforming to the requirements of ASTM D1248 and a standard bituminous outer coating.

PART 3 - EXECUTION

3-1. DUCTILE IRON PIPE

The Contractor shall conform to the installation requirements of Section 02535 - Gravity Flow Sanitary Sewers, and Section 02538 - Sanitary Sewer Service Lateral Reconnection and Repairs.

The joining of push-on joint ductile iron pipe shall be performed in accordance with the AWWA Standard for Installation of Ductile Iron Water Mains, Section 9C. Instructions for assembly of push-on joints may vary according to the particular manufacturer. The procedure for joining pipe equipped with push-on joints must therefore be in accordance with the instructions of the manufacturer of the particular joint furnished.

For push-on ductile iron pipe, the inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the socket. A thin coating of gasket lubricant shall be applied to both the inside surface of the gasket and outside surface of the spigot. Gasket lubricant shall be as supplied by the particular manufacturer and approved by the Engineer.

For mechanical joint pipe and fittings, the ends of the two (2) pieces of pipe to be joined (outside 8" of spigot and inside 8" of bell) shall first be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter, and then shall be painted with a soap solution made by dissolving one-half (½) cup of granulated soap in one (1) gallon of water.

The ductile iron gland shall then be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket end. The rubber gasket shall be painted with the soap solution and placed on the spigot end with the thick edge toward the gland. The entire section of the pipe shall be pushed forward to seat the spigot end in the bell. The gasket shall then be pressed in place within the bell, care being taken to locate the gasket evenly around the entire joint.

The ductile iron gland shall be moved along the pipe and into position for bolting, all of the bolts shall be inserted, and the nuts shall be fastened finger-tight. All nuts shall then be tightened with a suitable (preferable torque-limiting) wrench. Nuts spaced one-hundred and eighty (180) degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland. The torque for various sizes of bolts shall be as follows:

Bolt Size (inches)	Range of Torque (ft-lbs)
⅝	40 - 60
¾	60 - 90
1	70 - 100
1 ¼	90 - 120

3-2. FITTINGS

The Contractor shall install fittings in accordance with applicable ANSI/AWWA standards and manufacturers' recommendations.

3-3. TESTING

Following the installation of ductile iron pipe, the Contractor shall air test all sewer pipe joints in accordance with the requirements of Section 02650 - Testing for Acceptance of Sanitary and Storm Sewers. Joints failing the air test are subject to rejection, repair, or replacement at the Contractor’s expense.

End of Section

SECTION 02575

REMOVING AND REPLACING PAVEMENT

PART 1 – GENERAL

1-1. DESCRIPTION

The Work to be performed under this Section shall consist of existing pavement, sidewalks, steps, patios, curbs, and gutters in paved areas where such have been removed or damaged for construction of utilities and appurtenances. The Contractor shall remove and replace the top 2 inches of pavement and raise the rim on street MHs. The Contractor shall also repair any damaged areas of pavement that are deeper than 2 inches to match thickness of each course of the existing pavement system.

Existing pavement, sidewalks, curbs, and gutters shall be replaced to meet the current City of Atlanta standards, or to match existing pavement sidewalk, curb, or gutters; whichever is more stringent.

1-2. REFERENCES

1-2.01. Reference Standard: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. AASHTO, American Association of State Highway and Transportation Officials.
2. ASTM, American Society for Testing Materials.
3. Note: Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1-2. SUBMITTALS

If required by the City or Engineer, provide certificates stating that materials supplied comply with Specifications. Certificates shall be signed by the asphalt producer and the Contractor.

1-3. SPECIAL REQUIREMENTS

1-3.01. Weather Limitations:

1. Apply bituminous tack coat only when the ambient temperature in the shade has been at least 50 degrees Fahrenheit for 12 hours immediately prior to application.
2. Do not conduct paving operations when surface is wet or contains excess of moisture that would prevent uniform distribution and required penetration.

3. Construct asphaltic courses only when atmospheric temperature in the shade is above 40 degrees Fahrenheit, when the underlying base is dry and when weather is not rainy.
4. Place base course when air temperature is above 35 degrees Fahrenheit and rising.

1-3.02. Grade Control: Establish and maintain the required lines and grades for each course during construction operations.

PART 2 – PRODUCTS

2-1. MATERIALS AND CONSTRUCTION

2-1.01. Graded Aggregate Base: The subbase shall be a minimum of 6-inches thick and a width equal to the width of the finished paving. Aggregate base shall be Class "A," meeting the requirements of the Georgia Department of Transportation Specification Section 815.01. Compact to at least 95 percent Standard Proctor Density. (ASTM D-698)

2-1.02. Base: The base for all paved roadways shall conform to the requirements of the Georgia Department of Transportation Specifications for the Hot Mix asphalt Section 828 Type "B".

2-1.03. Tack Coat: Tack coat shall conform to Section 413 of the Georgia Department of Transportation Standard Specifications.

2-1.04. Binder Course: The binder course of all paved roadways shall conform to the requirements of Section 400, Type "B" of the Georgia Department of Transportation Standard Specifications.

2-1.05. Surface Course: The surface course for all pavement, including prime or tack coat when required by the Engineer, shall conform to the requirements of Section 400, Type "E" of the Georgia Department of Transportation Standard Specifications

2-1.06. Concrete: Provide concrete and reinforcing for concrete pavement or base courses in accordance with the requirements of the Georgia Department of Transportation Standard Specifications, Section 430. Concrete shall be minimum 3,000 psi compressive strength or as otherwise shown on the Drawings.

2-1.07. Special Surfaces: Where pavement, sidewalks, steps, patios, curbs, or gutters are disturbed or damaged which are constructed of specialty type surfaces, e.g., brick or stone, these facilities shall be restored utilizing similar, if not original, materials. Where the nature of these surfaces dictate, a specialty contractor shall be used to restore the surfaces to their previous or better condition. Special surfaces shall be removed and replaced to the limits to which they were disturbed.

2-2. TYPES OF PAVEMENTS

2-2.01. General: All existing pavement removed, destroyed or damaged by construction shall be replaced with the same type and thickness of pavement as that existed prior to construction, unless otherwise directed by the City or Engineer. Materials, equipment and construction methods used for paving work shall conform to the Georgia Department of Transportation specifications applicable to the particular type required for replacement, repair, or new pavements.

2-2.02. Aggregate Base: Aggregate base shall be constructed in accordance with the requirements of Section 310 of the Georgia Department of Transportation Standard Specifications. The maximum thickness to be laid in a single course shall be 6 inches compacted. If the design thickness of the base is more than 6 inches, it shall be constructed in two or more courses of approximate equal thickness. After the material placed has been shaped to line, grade, and cross section, it shall be rolled until the course has been uniformly compacted to at least 100 percent of the maximum dry density when Group 2 aggregate is used, or to at least 98 percent of maximum dry density when Group 1 aggregate is used.

2-2.03. Concrete Pavement: Concrete pavement or base courses shall be replaced with concrete. The surface finish of the replaced concrete pavement shall conform to that of the existing pavement. The surface of the replaced concrete base course shall be left rough. The slab depth shall be equivalent to the existing concrete pavement or base course, but in no case less than 6 inches thick. Transverse and longitudinal joints removed from concrete pavement shall be replaced at the same locations and to the same types and dimensions as those removed. Concrete pavements or concrete base courses shall be reinforced.

2-2.04. Asphaltic Concrete Base, Bituminous Tack Coat, Binder, and Surface Course: Asphaltic concrete base, tack coat, and surface course construction shall conform to Georgia Department of Transportation Standard Specifications, Section 400. The pavement mixture shall not be spread until the designated surface has been previously cleaned and prepared; surface is intact, firm, properly cured, dry; and the tack coat has been applied. Apply and compact the base in maximum layer thickness by asphalt spreader equipment of design and operation approved by the City or Engineer. After compaction, the black base shall be smooth and true to established profiles and sections. Apply and compact the surface course in a manner approved by the City or Engineer. Immediately correct any high, low, or defective areas by cutting out the course, replacing with fresh hot mix, and immediately compacting to conform and thoroughly bond to the surrounding area.

2-2.05. Surface Treatment Pavement: Bituminous penetration surface treatment pavement shall be replaced with a minimum thickness of 1 inch conforming to Section 424, Georgia Department of Transportation Standard Specifications.

2-2.06. Gravel Surfaces: Existing gravel road, drive, and parking area replacement shall meet the requirements of graded aggregate base course. This surfacing may be authorized by the City or Engineer as a temporary surface for paved streets until replacement of hard surfaced pavement is authorized.

2-2.07. Temporary Measures: During the period between pavement removal and complete replacement of permanent pavement, maintain highways, streets, and roadways by the use of steel running plates anchored to prevent movement. The backfill above the pipe shall be compacted, as specified in Section 02200 of this Specification, up to the existing pavement surface to provide support for the steel running plates. All pavements shall be replaced within 7 calendar days of their removal.

PART 3 – EXECUTION

3-1. LOCATIONS FOR PAVEMENT REPLACEMENT

3-1.01. Pavement Replacement:

1. All trenches for roadway crossings
2. All trench longitudinal installations
3. All locations where pavement must be removed or is damaged in the execution of the Work

3-1.02. "Graded Aggregate" pavement repair shall be used only where approved by the City or Engineer.

3-2. REMOVING PAVEMENT

3-2.01. General: Remove existing pavement as necessary. Existing pavement and sub-base shall be removed.

3-2.02. Marking: Before removing any pavement, mark the pavement neatly.

3-2.03. Saw Cutting: Under no circumstances shall the Contractor be allowed to remove concrete or asphalt without prior saw cutting. Asphalt pavement shall be saw cut along the marks using suitable equipment. The saw cutting shall be deep enough to produce an even, straight cut.

3-2.04. Breaking: Break asphalt pavement along the marks using pavement shearing equipment, jackhammers or other suitable tools. Break concrete pavement along the marks by scoring with a rotary saw and breaking below the score by the use of jackhammers or other suitable tools.

3-2.05. Machine Pulling: Do not pull pavement with machines until the pavement is completely broken and separated from pavement to remain.

3-2.06. Damage to Adjacent Pavement: Do not disturb or damage the adjacent pavement. If the adjacent pavement is disturbed or damaged, remove and replace the damaged pavement at no additional cost to the City.

3-2.07. Sidewalks and Patios: Remove and replace any sidewalks or patios disturbed by construction for their full width and to the nearest undisturbed joint.

3-2.08. Curbs and Gutters: Tunnel under or remove and replace any curb and/or gutter, which is disturbed by construction to the nearest undisturbed joint.

3-2.09. Steps: Completely remove and replace any steps, constructed of concrete or special surfaces, which are disturbed by construction.

3-3. REPLACING PAVEMENT

3-3.01. Preparation of Subgrade: Upon completion of backfilling and compaction of the backfill, arrange to have the compaction tested by an independent testing laboratory approved by the City or Engineer. After compaction testing has been satisfactorily completed, replace all pavements, sidewalks, and curbs removed.

The existing street pavement or surface shall be removed or milled along the lines of the work from edge of pavement to edge of pavement. Pavement shall be replaced from edge of existing pavement to edge of existing pavement.

Trench backfill shall be compacted for the full depth of the trench as specified in Section 02202 of this Specification.

Temporary trench backfill along streets and driveways shall include 6 inches of crushed stone or cherty clay as a temporary surfacing of the trenches. This temporary surface shall be maintained carefully at grade, dust free, by the Contractor until the backfill of the trench has thoroughly compacted in the opinion of the City or Engineer, and permission is granted to replace the pavement.

When temporary crushed stone or chert surface is considered by the City or Engineer to be sufficient surface for gravel pavement, the surface shall be graded smooth and to an elevation that will make the final permanent surfacing level with the adjacent surfacing that was undisturbed.

3-3.02. Pavement Replacement: Prior to replacing pavement, make a final cut in concrete pavement 12 inches back from the edge of the damaged pavement with a concrete saw. Remove asphalt pavement 12 inches back from the edge of the damaged pavement using pavement-shearing equipment, jackhammers or other suitable tools.

Replace and repave all street and roadway pavement from edge of pavement to edge of pavement as shown on the Drawings; as shown on the details contained herein.

Replace driveways, sidewalks, and curbs with the same material, to nearest existing undisturbed construction joint and to the same dimensions as those existing.

If the temporary crushed stone or chert surface is to be replaced, the top 6 inches shall be removed and the crushed stone surfacing for unpaved streets or the base for the bituminous surface shall be placed.

Following this preparation, the chert or crushed stone base shall be primed with a suitable bituminous material and surfaced with the proper type of bituminous surface treatment.

Where the paved surface is to be replaced with asphaltic concrete pavement, concrete pavement or with a concrete base and a surface course, the temporary chert or crushed stone surface and any necessary backfill material, additional existing paving and new excavation shall be removed to the depth and width shown on the Drawings/details. All edges of the existing pavement shall be cut to a straight, vertical edge. Care shall be used to get a smooth joint between the old and new pavement and to produce an even surface on the completed street. Concrete base slabs and crushed stone bases, if required, shall be placed and allowed to cure for three days before bituminous concrete surface courses are applied. Expansion joints, where applicable, shall be replaced in a manner equal to the original joint.

Where driveways or roadways, constructed of specialty type surfaces, e.g., brick or stone are disturbed or damaged, these driveways and roadways shall be restored utilizing similar materials. Where the nature of these surfaces dictate, a specialty contractor shall be used to restore the surfaces to their previous or better condition. Special surfaces shall be removed and replaced to the limits to which they were disturbed.

3-3.03. Pavement Resurfacing: After all pipeline installations are complete and existing pavement has been removed or milled from edge of pavement to edge of pavement, apply tack coat and surface course as specified.

Resurfacing limits shall be perpendicular to the road centerline. The limits of resurfacing shall be 10 feet beyond the edge of the pavement replacement on the main road being resurfaced.

Where pavement damaged with potholes, the Contractor shall remove all existing loose pavement material and fill the hole with black base, as specified, to the level of the existing pavement.

3-3.04. Pavement Striping: Pavement striping removed or paved over shall be replaced with the same type, dimension, and material as original unless directed otherwise by the City or Engineer.

3-3.05. Installation of Traffic Plates: Following completion of sewer works including backfilling but prior to replacement of pavement, steel plates shall be used to temporarily carry vehicular traffic as follows:

All steel plates shall meet ASTM structural specifications having “A36” designation with minimum yield stress of 36 ksi (ksi = kilopounds per square inch).

Asphaltic patching material (cold mix) shall be used to secure the steel plate around its edges. Alternatively, all sides of the plate or plates must be secured to the ground surface with A.R.E.A. standard railroad spikes. No spikes shall be left lying on the highway.

Trench must be backfilled to within eight (8) inches from top of existing pavement prior to placing the steel plate.

The width of a trench is measured normal to the length of the trench. The largest reading of the measurements is the determining factor for width. For a series of steel plates on any continuous trench, all plates must have the same thickness.

Trench must be fully covered with a minimum of twelve (12) inches of asphalt taper on all sides of the plate.

Upon the completion of the work, the existing surface shall be cleaned and pavement restored to the City of Atlanta standards.

3-4. SIDEWALK, CURB, AND GUTTER REPLACEMENT

3-4.01. Construction: All concrete sidewalks, curbs, and gutters shall be replaced with concrete.

Preformed joints shall be 1/2 inch thick, conforming to the latest edition of AASHTO M59 for sidewalks and AASHTO M 123 for curbs.

Forms for sidewalks shall be of wood or metal, shall be straight and free from warp, and shall be of sufficient strength, when in place, to hold the concrete true to line and grade without springing or distorting.

Forms for curbs shall be metal and of an approved section. They shall be straight and free from distortions, showing no vertical variation greater than 1/8 inch in 10 feet and no lateral variation greater than 1/4 inch in 10 feet from the true plain surface on the vertical face of the form. Forms shall be of the full depth of the structure and constructed such to permit the inside forms to be securely fastened to the outside forms.

Securely hold forms in place true to the existing lines and grades.

Wood forms may be used on sharp turns and for special sections, as approved by the City. Where wooden forms are used, they shall be free from warp and shall be the nominal depth of the structure.

All mortar and dirt shall be removed from forms and all forms shall be thoroughly oiled or wetted before any concrete is deposited.

3-4.02. When a section is removed, the existing sidewalk, curb, or gutter shall be cut to a neat line, perpendicular to both the centerline and the surface of the concrete slab. Existing concrete shall be cut along the nearest existing construction joints; if such joints do not exist, the cut shall be made at minimum distances shown on the Drawings.

3-4.03. Existing concrete sidewalks, curbs, and gutters that have been cut and removed for construction purposes shall be replaced with the same width and surface as the portion removed. Sidewalks shall have a minimum uniform thickness of 4 inches. The new work shall be neatly jointed to the existing concrete so that the surface of the new work shall form an even, unbroken plane with the existing surfaces.

3-4.04. The subgrade shall be formed by excavating to a depth equal to the thickness of the concrete, plus 2 inches. Subgrade shall be of such width as to permit the proper installation and bracing of the forms. Subgrades shall be compacted by hand tamping or rolling. Soft, yielding or unstable material shall be removed and backfilled with satisfactory material. Place 2 inches of porous crushed stone under all sidewalks, curbs, and gutters and compact thoroughly, then finish to a smooth, unyielding surface at proper line, grade, and cross-section.

3-4.05. Joint for Curbs and Gutters: Construct joints true to line with their faces perpendicular to the surface of the structure and within 1/4 inch of their designated position.

Thoroughly spade and compact the concrete at the faces of all joints filling all voids.

Install expansion joint materials at the point of curve at all street returns. Install expansion joint material behind the curb at abutment to sidewalks and adjacent structures.

Place contraction joints every 10 feet along the length of the curbs and gutters. Form contraction joints using steel templates or division plates which conform to the cross section of the structure. Leave the templates in place until the concrete has set sufficiently to hold its shape, but remove them while the forms are still in place. Contraction joint templates or plates shall not extend below the top of the steel reinforcement or they shall be notched to permit the reinforcement to be continuous through the joint. Contraction joints shall be a minimum of 1 1/2 inches deep.

3-4.06. Expansion joints shall be required to replace any removed expansion joints or in new construction. Expansion joints shall be true and even, shall present a satisfactory appearance, and shall extend to within 1/2 inch of the top of finished concrete surface.

3-4.07. Finishing: Strike off the surface with a template and finish the surface with a wood float using heavy pressure, after which, contraction joints shall be made and the surface finished with a wood float or steel trowel.

Finish the face of the curbs at the top and bottom with an approved finishing tool of the radius indicated on the Drawings.

Finish edges with an approved finishing tool having a 1/4 inch radius.

Provide a final broom finish by lightly combing with a stiff broom after troweling is complete.

The finished surface shall not vary more than 1/8 inch in 10 feet from the established grade.

3-4.08. Driveway and Sidewalk Ramp Openings: Provide driveway openings of the widths and at the locations directed by the City or Engineer.

Provide sidewalk ramp openings in conformance with the applicable regulations and as directed by the City or Engineer.

3-4.09. Concrete shall be suitably protected from freezing and excessive heat. It shall be kept covered with burlap or other suitable material and kept wet until cured. Provide necessary barricades to protect the work. All damage caused by people, vehicles, animals, rain, the Contractor's operations and the like shall be repaired by the Contractor, at no additional expense to the City.

3-5. MAINTENANCE

The Contractor shall maintain the surfaces of roadways built and pavements replaced until the acceptance of the Project. Maintenance shall include replacement, scraping, reshaping, wetting, and re-rolling as necessary to prevent raveling of the road material, the preservation of reasonably smooth surfaces and the repair of damaged or unsatisfactory surfaces, to the satisfaction of the Engineer. Maintenance shall include sprinkling as may be necessary to abate dust from the gravel surfaces.

3-6. SUPERVISION AND APPROVAL

3-6.01. Pavement restoration shall meet the requirements of the regulatory agency responsible for the pavement. Obtain agency approval of pavement restorations before requesting final payment.

3-6.02. Obtain the City’s or Engineer’s approval of restoration of pavement, such as private roads and drives that are not the responsibility of a regulatory agency.

3-6.03. Complete pavement restoration as soon as possible after backfilling.

3-6.04. Failure of Pavement: Should any pavement restoration or repairs fail or settle during the life of the Contract, including the bonded period, promptly restore or repair defects.

3-6.05. Prior to acceptance and approval of any asphaltic concrete binder and/or topping which is installed for the purpose of City maintenance, a representative of the City of Atlanta's Department of Traffic and Transportation may require one or all of the following tests: 1) coring, 2) extraction, 3) compaction, 4) density. The frequency and location of these tests will be left up to the discretion of the Inspector/Engineer.

3-7. CLEANING

The Contractor shall remove all surplus excavation materials and debris from the street surfaces and rights-of-way and shall restore street, roadway, or sidewalk surfacing to its original condition.

3-8. TRAFFIC CONTROL

Refer to General Conditions and Supplemental Conditions for Traffic Control and Temporary Control of Construction Operations for requirements.

END OF SECTION

SECTION 02600

WASTEWATER FLOW CONTROL

PART 1 - GENERAL

1-1. SCOPE

Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of wastewater flow control; plugging and blocking; pumping and bypassing; flow control precautions; and any other similar, incidental, or appurtenant flow control operation which may be necessary to properly complete the Work as shown on the Drawings and Specified herein.

The Contractor shall provide all services, labor, materials, and equipment required for all flow control and related operations necessary or convenient to the Contractor for furnishing a complete Work as shown on the Plans or specified in these Specifications.

1-2. SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

The design, installation, and operation of the wastewater flow control system shall be the Contractor's responsibility. The Contractor shall employ the services of a vendor that can demonstrate to the Engineer that the vendor specializes in the design and operation of wastewater flow control systems. The vendor shall provide at least three (3) references of projects of a similar size and complexity as this Project, which were successfully performed by the vendor's firm within the past three (3) years. The references shall include the name of the agency, the name of the project, the date of the project, and the agency contact (telephone, fax, and e-mail). The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

A general description of the proposed Wastewater Flow Control to include the make and model of temporary bypass pumps, the certified noise levels of the pumps and generator, the means used to maintain and operate the bypass pumps, and a written statement that all bypass pumping shall comply with the requirements of these Specifications.

During the course of the project, the detailed, work-specific Wastewater Control Plan utilizing multiple pumps, or a single pump greater than four (4) inches discharge, shall be submitted to the Engineer at least ten (10) days before required. This plan shall outline all provisions and precautions to be taken by the Contractor regarding the handling of existing wastewater flows. This plan shall be specific and complete, including such items as schedules, locations, elevations, capacities of equipment,

materials, and all other incidental items necessary and/or required to insure adequate wastewater control. The plan shall also include details of protection of the access and bypass pumping locations from damage due to the discharge flows, and compliance with the requirements and permit conditions specified in these Specifications. No construction shall begin until all provisions and requirements have been reviewed and accepted by the Engineer.

The Contractor shall submit two (2) copies of the wastewater control plan for each sewer bypass set-up with sufficient detail including the following:

1. Staging areas for pumps.
2. Sewer plugging method and types of plugs.
3. Number, size, material, location, and method of installation of suction piping.
4. Bypass pump sizes, capacity, number of each size to be on the site of the Work and power requirements.
5. Calculations of static lift, friction losses, and flow velocity (pump curves) showing pump-operating range.
6. Standby power generator size and location.
7. Downstream piping and discharge plan.
8. Method of protecting discharge manholes or structures from erosion and damage.
9. Thrust and restraint block sizes and locations.
10. Sections showing suction and discharge pipe depth, embedment, select fill, and special backfill where required.
11. Certified decibel levels of individual pumps, the combined decibel level if multiple pumps will be operated simultaneously, and the method of noise control for each pump and/or generator.
12. Any temporary pipe supports, including rollers and elevated rollers, as well as anchoring required.
13. Design plans and computations for access to bypass pumping locations.
14. Calculations for selection of bypass pumping pipe size.
15. Schedule for installation of and maintenance of bypass pumping lines.
16. Plan indicating selection location of bypass pumping line locations.

The Plan shall indicate the means by which flows from laterals are provided for either by plugging, containing, or subsidiary pumping. Building laterals shall not be disconnected or plugged overnight. Plugging of laterals is only allowed from 9 a.m. until 5 p.m. of the same day.

Any proposal to implement wastewater flow control arrangements on sewers, including plugging and/or blocking, high-velocity nozzles, and/or bypass and/or diversion pumping as well as any sewer rehabilitation, repair, or replacement construction, shall be outlined in writing and submitted to the Engineer at least ten (10) days prior to the implementation of the wastewater flow control system, sewer rehabilitation, repair, or replacement.

All proposed wastewater flow control arrangements, including flow bypass and/or diversion plans, shall indicate or show the location and position, in detail if necessary, any special features where pipes or hoses cross roadways, including intersections, such as temporary trenches, support bridges, ramp-overs, etc.

All proposed wastewater flow control arrangements, including wastewater flow bypass and/or diversion pumping plans for sewers, shall also include an emergency response plan to be followed in the event of a failure of the wastewater flow control system. The Contractor shall provide names and phone numbers for twenty-four (24) hour emergency contact.

The Contractor shall notify the Engineer twenty-four (24) hours prior to commencing actual wastewater flow control operations. The Contractor's Wastewater Flow Control Plan shall be approved by the Engineer before the Contractor shall be allowed to commence wastewater flow control work.

1-3. GENERAL

The objective of wastewater flow control is to: Maintain an efficient and uninterrupted level of service to wastewater collection system users while maintenance or construction operations (including rehabilitation, repair, replacement, or connection of newly constructed facilities) are facilitated on the segment or segments being bypassed and/or from which flow is being diverted, within the wastewater collection system.

Ensure that all levels of wastewater flow are continuously and effectively handled around the segment or segments of sewer being bypassed and/or from which flow is being diverted by:

Ensuring that bypass and diversion pumps are adequately fueled, lubricated, and maintained.

Ensuring backup spare parts are expeditiously applied to the flow bypass and/or diversion pumping system in the event of component breakdown.

Ensuring that an emergency backup plan is smoothly implemented in the event of system failure.

Preventing backup, spillage, flooding, or overflow onto streets, yards, and unpaved areas or into buildings; adjacent ditches; storm sewers; and waterways; while flow bypass or diversion pumping takes place and ensuring that installation, startup, and subsequent disassemby of the flow bypass and diversion pumping system is smoothly transitioned

1-4. REGULATORY REQUIREMENTS

The work of this section shall comply with the current versions, with revisions, of the following:

OSHA 29 CFR 1910.146 (permit-required confined-space regulations)

All Work and testing shall comply with the applicable Federal codes, including Federal Occupational Safety and Health Act of 1970 and the Construction Safety Act of 1969, as amended, and applicable state and local codes and standards; and to the extent applicable with the requirements of the Underwriter's Laboratories, Inc. and the National Electric Code.

PART 2 - PRODUCTS

2-1. PIPE FOR FLOW DIVERSION

Ductile Iron Pipe: Ductile iron pipe as specified in Section 02537 - Ductile Iron Sanitary Sewer Pipe and Fittings is acceptable for use for flow diversion during construction.

Polyethylene Pipe: Polyethylene material shall comply with the requirements for Type III polyethylene, C-5 and P-34 as tabulated in ASTM D1248 and have the Plastic Pipe Institute recommended designation PE3406. The material shall also have an average specific base resin density of between 0.94 g/cc and 0.955 g/cc (ASTM D1505). Pipe made from these resins must have a long term strength (50 years) rating of 1,250 psi or more per hydrostatic design basis categories of ASTM D2837. The polyethylene resin shall contain antioxidants and be stabilized against ultraviolet degradation to provide protection during processing and subsequent weather exposure. The polyethylene resin shall have an environmental stress crack resistance, condition C as shown in ASTM D1693, to be greater that five-hundred (500) hours, twenty (20) percent failure.

All pipe shall be made from virgin quality material. No rework compound, except that obtained from the manufacturer's own production of the same formulation shall be used. The polyethylene resin shall have an average melt flow index, condition E as shown in ASTM D1238, not in excess of 0.25 g/10 min. Pipe shall be homogeneous throughout, and free of visible cracks, holes, foreign material, blisters, or other deleterious faults. Diameters and wall thickness shall be measured in accordance with the requirements of ASTM D2122. Pipe joining will be done by thermal butt fusion method in accordance with the requirements of ASTM D657.

2-2. PUMPING EQUIPMENT

All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps may be electric or diesel powered, provided they meet all specified sound level requirements. If electric pumps are used, the combined generator/pump system shall meet the specified sound level requirements. All pumps used shall be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows.
Unless specified otherwise in these Specifications or approved by the Engineer, all pumps (and generators if used) shall be fully sound attenuated and shall produce a noise level of sixty-five (65) dBA or less at a distance of twenty-three (23) feet.

The Contractor shall provide the necessary stop/start controls for each pump.

The Contractor shall include one stand-by pump of each size to be maintained on site of the Work. Back-up pumps shall be on-line, isolated from the primary system by a valve.

The Contractor shall design all piping, joints, and accessories to withstand twice the maximum system pressure or fifty (50) psi, whichever is greater. The back-up pump, appropriate piping, fuel, lubrication, and spare parts shall be incorporated into the bypass arrangement at the site of the Work, ready for use in case of breakdown. A bypass "drill" shall be carried out by the Engineer before the bypass arrangement is accepted on all sewers greater than twelve (12) inches in diameter, at no cost to the City. The drill shall demonstrate the incorporation of all standby equipment to handle flows when the main pump set is switched off. The Engineer's instructions following the drill shall be adhered to in full at no cost to the City.

No more than two (2) pump discharge hoses shall be used for wastewater flow control over a length of the line segment(s). If the flow exceeds the capacity of (2) "hoses" then rigid piping shall be used. The rigid piping shall consist of Ductile Iron Pipe, HDPE, or steel pipes with suitable pressure rated couplings to withstand twice the maximum system pressure or fifty (50) psi, whichever is greater.

Under no circumstances will aluminum "irrigation" type piping or glued PVC pipe be allowed. Discharge hose will only be allowed in short sections and by specific permission from the Engineer.

2-3. SYSTEM DESCRIPTION

2-3.01. Design Requirements: Bypass pumping systems shall have sufficient capacity to pump peak flows in the pipes being bypassed (flows in the existing sewers can increase dramatically during periods of wet weather). The Contractor shall provide all pipeline plugs, pumps of adequate size to handle wet weather peak flows, and temporary discharge piping to ensure that the total flow of the mainline is safely diverted around the section to be repaired. Wastewater flow control system will be required to be operated twenty-four (24) hours per day.

The table below includes flow data. The Contractor may utilize this data, as a general indication of peak flows into the facility for which bypass pumping is to be provided. The Contractor, however, is responsible for conducting such additional flow measurements as may be required to provide adequate bypass pumping capacity.

Facility	Minimum Hourly Flow (MGD)	Average Daily Flow (MGD)	Peak Hourly Flow (MGD)	Peak Daily Flow (MGD)
ICWRC	2	12	50	32
SRWRC	5	22	85	45

The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One (1) standby pump for each size pump utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.
Bypass pumping systems used to temporarily pump completed portions of the newly separated sewer into the existing combined trunk shall be sized using the COA Gravity Sewer Design Guide, latest revision available.

The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One (1) standby pump for each size pump utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.

The wastewater flow control system shall be capable of bypassing the flow around the work area and of releasing any amount of flow, up to full available flow, into the work area as necessary for satisfactory performance of the Work.

The Contractor shall make all arrangements for bypass pumping during the time when the mainline is shut down for any reason. The wastewater flow control system shall overcome any existing force main pressure on discharge.

2-3.02 Performance Requirements: It is essential to the operation of the existing wastewater system that there is no interruption in the flow of wastewater throughout the duration of the project. To this end, the Contractor shall provide, maintain, and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the wastewater flow before it reaches the point where it would interfere with the Work, carry it past the Work, and return it to the existing sewer downstream of the work.
The design, installation, and operation of the wastewater flow control system shall be the Contractor's responsibility. The wastewater flow control system shall be the Contractor's responsibility.

The Contractor shall provide all necessary means to safely convey the wastewater past the work area. The contractor will not be permitted to stop or impede the mainline flows under any circumstances.

The Contractor shall maintain wastewater flow around the work area in a manner that will not cause surcharging of sewers, damage to sewers, and that will protect public and private property from damage and flooding.

The Contractor shall protect water resources, wetlands, and other natural resources.

PART 3 - EXECUTION

3-1. PLANNING

The Contractor shall be solely responsible for planning and executing all wastewater flow control operations. The Contractor shall be entirely liable for damages to private or public property that may result from his operations and for all cleanup, disinfection, damages, and resultant fines in the event of a spillage, flooding, or overflow.

3-2. GENERAL

All materials used for wastewater flow control shall be pre-approved by the Engineer prior to commencing wastewater flow control activities.

Before any wastewater flow control equipment is installed, the Contractor shall desilt the segment of sewer to be bypassed while it is still under flow. Subsequent jetting and final cleaning before rehabilitation or repair shall be undertaken while the segment of sewer is bypassed.

The Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass pipelines. The Contractor shall locate his bypass pipelines to minimize any disturbances to existing utilities and shall obtain approval of the pipeline locations from the Engineer. All costs associated with relocating utilities and obtaining all approvals shall be paid by the Contractor.

During all wastewater flow control operations, the Contractor shall protect mainlines, manholes, and all local sewer lines from damage inflicted by any equipment. The Contractor shall be responsible for all physical damage to mainlines, manholes, and all local sewer lines caused by human or mechanical failure.

When wastewater flows at the upstream manhole of the manhole section being repaired are above the maximum allowable requirements for television inspection, or do not allow the proper sewer or manhole repair, the flows shall be reduced to the levels required by one of the following methods: plugging/blocking of the flows, or pumping/bypassing of the flows as approved by the Engineer.

In some applications, the wastewater flow may be plugged and contained within the capacity of the collection system. This shall only be done when it has been determined, by the Engineer, that the system can accommodate the surcharging without any adverse impact.

If required by the Engineer, for television inspection, before abandoning a sewer, the Contractor shall block the sewer line completely. No flow, except infiltration/inflow, will be allowed through the respective sewer line being televised.

When sewer line flows are too excessive to plug while service lines are being removed and reconnected to the new sanitary sewer, the Contractor shall submit a written plan and pump/bypass the flow as acceptable to the Engineer.

When existing combined, storm, or sanitary sewers are required to be taken up, moved, or rebuilt, the Contractor, at his own expense, shall provide and maintain temporary outlets and connections for all private or public drains, sewers, and sewer outlets connected to or served by the sewers to be rebuilt, and where necessary, shall provide adequate pumping facilities; and shall maintain these services until such time as the permanent sewers and connections are built and in service at no cost to the City.

During construction, flows in sections of the existing combined sewer being rehabilitated/repaired by removal and replacement shall be accommodated by temporary flow diversion. Wastewater flow diversion shall be accomplished as specified in this section, unless otherwise shown on the Plans.

The Contractor shall use the provided construction easement for the flow diversion if not otherwise shown on the Plans. It shall be the Contractor's option to lay diversionary pipe within the construction easement. The Contractor shall use ingenuity and skill to develop a flow diversion program. The program must keep the wastewater flowing without discharge or spills into the creek or on the ground. The Contractor shall seek and obtain inspection of each section of newly laid sewer before taking the diversion out of service and placing the newly laid section in service.

In sections of the existing combined sewer being rehabilitated/repaired by laying a new line parallel to the existing combined sewer, the existing sewer may be used to accommodate the existing flow, and no temporary flow diversion will be necessary if the existing combined sewer is not damaged or its use restricted by the Contractor's operations.

All pipe materials utilized in wastewater flow diversion during construction shall be in good condition, and free of defects, and leaks. Any defective material shall be replaced by the Contractor at no cost to the City. Upon completion of the job, pipe materials shall be removed from the site.

The Contractor shall complete all wastewater flow control activities with the minimum sound level compatible with accepted industry standards for sound attenuated temporary pumping systems.

When pumps are operating, an experienced bypass/diversion pump maintenance operator, mechanic, and/or assistant shall continuously be on site to monitor the

operation of the entire bypass/diversion system. The operator, mechanic, and/or assistant shall comprehensively, methodically, and continuously:

1. Adjust pump speed as appropriate so as not to adversely impact upstream or downstream flow condition levels.
2. Check that the effectiveness and security of bulkheads, dams, diaphragms, plugs, valves, weirs, and all other flow control devices are working effectively and according to plan.
3. Check the integrity of hoses and couplings along the entire bypass/diversion system.
4. Monitor fuel tanks and top up as appropriate.
5. Monitor lubrication levels and top up as necessary.
6. Facilitate minor repairs as required.
7. Report on potential problems arising.
8. Inspect bypass-pumping system at least hourly to ensure that the system is working correctly.
9. Maintain adequate supply of spare parts on site as required

3-3. DEPTH OF FLOW

In performing television inspection, joint testing, and joint sealing work, the Contractor shall control the depth of flow in the sewer within the following guidelines:

MAXIMUM PIPE FLOW DEPTH			
TELEVISION INSPECTION		JOINT TESTING AND SEALING	
PIPE SIZE	% PIPE DIA.	PIPE SIZE	% PIPE DIA.
6"-10"	20	6"-12"	25
12"-24"	25	15"-24"	30
27" or larger	30	27" or larger	35

When sewer line flows, as measured in the first manhole upstream of the sewer segment being rehabilitated, televised, or tested exceed the maximum depth listed above or inspection of the complete pipe periphery is necessary for effective testing, sealing, or line work, the Contractor shall implement wastewater flow control methods at no additional cost to the City.

3-4. PLUGGING AND BLOCKING

The Contractor shall insert a sewer line plug into the line at a manhole upstream from the section being inspected or repaired. The plug shall be so designed that all or any portion of the operation flow can be released. During the inspection portion of the operation, flows shall be shut off or reduced to within the maximum flow limits specified.

During repairs, the flows shall be shut off or pumped/bypassed, as approved by the Engineer. Wastewater flow shall be restored to normal following completion of work within the subject manhole to manhole section.

3-5. PUMPING AND BYPASSING

When Bypass Pumping is required, a pump size shall be recommended by the Contractor and approved by the Engineer. The Contractor shall supply the necessary pumps, conduits, and other equipment to divert the flow of wastewater around the manhole section in which the Work is to be performed. The bypass system shall be of sufficient capacity to handle existing flows plus additional flow that may occur during periods of rainstorms. The Contractor shall be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. A "setup" consists of the necessary pumps, conduits, and other equipment required to divert the flow of wastewater around a manhole to manhole section, from the start to finish of work performed in the manhole to manhole section.

Wastewater shall be pumped directly into the nearest available downstream manhole, provided that the existing sewer has capacity to transport the flow. The Contractor shall be responsible for keeping the pumps running continuously twenty four (24) hours a day if required, until the bypass operation is no longer required. The Contractor shall have standby pumps at all times.

Pumps and equipment shall be continuously monitored by a maintenance person capable of starting, stopping, refueling, and maintaining these pumps during the bypassing operations. If pumping is required on a twenty four (24) hour basis, engines shall be equipped in a manner to keep noise to a minimum.

3-6. FLOW CONTROL PRECAUTIONS

Where the wastewater flow is blocked or plugged, the Contractor shall be responsible for taking sufficient precautions to protect public health. The sewer lines shall also be protected from damage. The following shall apply:

No wastewater shall be allowed to back up into any homes or buildings.

No wastewater shall overflow any manholes, cleanouts, or any other access to the sewers.

No interruption of water and sewer utilities users upstream of the inspection/repair area shall be allowed to occur.

If any of the above occur or are expected to occur, the Contractor shall provide bypass pumping to alleviate one or all of the conditions. Additionally, the Contractor shall observe the conditions upstream of the plug and be prepared to immediately start bypass pumping, if needed.

Any sump pumps, bypass pumps, trash pumps, or any other type of pump which pulls wastewater or any type of material out of the manhole or sewer shall discharge the material into another manhole, or appropriate vehicle or container approved by the Engineer. Under no circumstances shall this material be discharged, stored, or deposited on the ground, swale, road, or open environment.

The Contractor shall take appropriate steps to ensure that all pumps, piping, and hoses that carry raw wastewater are protected from traffic. Traffic control shall be performed in accordance with the requirements of Section 01550 - Traffic Regulation.

In the event, during any form of "Wastewater Flow Control," that raw wastewater is spilled, discharged, leaked, or otherwise deposited in the open environment, due to the Contractor's work, the Contractor shall be responsible for any cleanup of solids and stabilization of the area affected. This work shall be performed at the Contractor's expense with no additional cost to the City. The Contractor shall also be responsible for notifying the sewer system maintenance personnel and complying with any and all regulatory requirements for cleaning up the spill at no additional cost to the City.

During wastewater flow control operations, the Contractor shall take proper precautions to prevent damage to existing sanitary sewer facilities, flooding, or damage to public or private property.

The Contractor shall make repairs or replacements or rebuild such damaged section or sections of existing sewers, as directed by the Engineer. All such repairs, replacements, and rebuilding shall be paid for by the Contractor.

The Contractor shall make such provisions as are necessary for handling all flows in existing sewers, connections, and manholes by pipes, flumes, or by other approved methods at all times, when his operations would, in any way, interfere with normal functioning of those facilities.

The Contractor shall be responsible for the removal of any debris and sedimentation in the existing sewers, laterals, and manholes, etc., which is attributable to the Work.

All operations shall be performed by the Contractor in strict accordance with OSHA and any applicable local safety requirements. Particular attention is directed to safety regulations for excavations and entering confined spaces.

It is the Contractor's responsibility to notify in writing any property owner having a sewer service connection being reconnected to the new sanitary sewer that such work is being performed. The Contractor shall notify property owners forty-eight (48) hours prior to commencing service reconnection. The Contractor shall be solely responsible for any damage caused by property service connection backups caused by his Work.

Piping used for temporary flow diversion of storm, combined, or gravity sewers shall not be used for temporary flow diversion of potable water.

End of Section

Section 02606

MANHOLE AND VAULT COVERS AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the fabrication and erection of iron manhole and vault covers and accessories suitable for installation in manholes, vaults, slabs, electrical handholes, and other applications where a floor access hatch is not required. Manhole steps (suitable for both cast-in-place and epoxy grouted installations) are also included. For floor access hatches and doors see the specification section of the same name.

Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1-2. SUBMITTALS. Complete data, detailed drawings, and setting or erection drawings covering all materials shall be submitted in accordance with the Submittals Procedures section. Each separate piece shall be marked.

1-3. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Materials shall be stored on blocking and protected from the weather so that no metal touches the ground and water cannot collect thereon.

PART 2 - PRODUCTS

2-1. GENERAL. Materials work shall be fabricated in conformity with dimensions, arrangements, sizes, and weights or thicknesses as specified or as indicated on the Drawings.

All members and parts shall be free of warps, local deformations, and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. All field connection materials shall be furnished.

2-2. DESIGN REQUIREMENTS. Manhole and electrical vault covers and frames shall be cast iron assemblies specifically intended as covers. Manufacturer, product number, and type shall be as specified.

All covers and frames shall be capable of carrying an AASHTO HS-20 street loading unless specifically indicated as light duty. An equivalent heavy duty cover and frame may be substituted for the indicated light duty cover and frame.

2-3. MATERIALS. Materials, appurtenances, and finishes used in the manufacturer of manhole and electrical handhole covers and frames shall be as indicated. Unless otherwise required, materials, appurtenances, and finishes shall be the manufacturer's standard for the type of each cover indicated.

Circular Covers and Frames	
Light Duty	Cast iron; Clay & Bailey "2020", Neenah "R-1737", or equal.
Heavy Duty (Subject to Vehicular Traffic)	Cast iron; Clay & Bailey "2008BV",, Neenah "R-1736", or equal.
Rectangular Covers and Frames	
Light Duty	
Square	Cast iron; Neenah "R-6660", or equal.
Rectangular	Cast iron; Neenah "R-6661", or equal.
Heavy Duty (Subject to Vehicular Traffic)	
Square	Cast iron; Neenah "R-6662", or equal.
Rectangular	Cast iron; Neenah "R-6663", or equal.
Manhole Steps	Cast iron; Neenah "R-1980-J", or equal.

PART 3 - EXECUTION

3-1. INSTALLATION. Prior to installation all loose rust shall be removed from castings and one coat of coal tar epoxy shall be applied to surfaces embedded in concrete. Materials shall be erected and installed in conformity with the dimensions and arrangements specified or indicated on the Drawings and as recommended by the manufacturer.

After erection covers and frames shall be cleaned. Product finishes damaged during erection, shall be repaired as recommended by the manufacturer.

End of Section

SECTION 02607

MANHOLES, JUNCTION BOXES, CATCH BASINS AND INLETS

PART 1 - GENERAL

1-1. SCOPE. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required to install cast-in-place, and precast concrete manholes, junction boxes, catch basins and inlets. The term manholes, as used, herein and shown on the Drawings includes manholes, junction boxes, catch basins and inlets. All work shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

Related Work Specified Elsewhere:

1. Section 02200, Site Work.
2. Section 03200, Concrete Reinforcement and Dowelling.
3. Section 03300, Cast-In-Place-Concrete.

1-2. SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided.

Complete shop drawings and engineering data on frames, covers, steps and precast manhole sections and flotation calculations shall be submitted to the Engineer in accordance with the requirements of the General Conditions of the Contract Documents.

1-3. QUALITY ASSURANCE. Prior to delivery, all basic materials specified herein shall be tested and inspected by an approved independent commercial testing laboratory or, if approved by the Engineer, certified copies of test reports prepared by the manufacturer's testing laboratory will be acceptable. All materials which fail to conform to these Specifications shall be rejected.

After delivery to the site, any materials which have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the site.

1-4. QUALITY STANDARDS. Manufacturers offering products that comply with these specifications include:

1. Standard manhole frame and cover.
   a. Vulcan Foundry, VM-26.
   b. Neenah Foundry, Series R-1700.
   c. Or equal.

2. Manhole adjusting rings.
    a. Neenah Foundry, R1979-H.
    b. Higgins Foundry,
    c. Or equal.
3. Manhole rungs.
    a. M.A. Industries.
    b. Or equal.

1-5. WARRANTY. Provide a warranty against defective materials and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2-1. GENERAL. Manholes shall be constructed of specified materials to the sizes, shapes and dimensions and at the locations shown on the Drawings or as otherwise directed by the Engineer. The height or depth of the manhole will vary with the location, but unless shown otherwise on the Drawings, shall be such that the top of the manhole frame will be at the finished grade of the pavement or ground surface and the invert will be at the designated elevations.

2-2. MATERIALS AND CONSTRUCTION

2-2.01. Concrete and Reinforcement: Concrete used in manhole and junction chamber construction shall be Class "A" concrete conforming to the requirements of Section 03300, Cast-In-Place Concrete. Steel reinforcement shall conform to the requirements of Section 03200, Concrete Reinforcement and Dowelling.

2-3. PRECAST CONCRETE MANHOLES

2-3.01. Precast concrete manholes shall consist of precast reinforced concrete sections, a conical or flat slab top section, and a base section conforming with the typical manhole details as shown on the Drawings. Precast manhole section shall be manufactured, tested and marked in accordance with the latest provisions of ASTM C 478. The minimum compressive strength of the concrete for all sections shall be 4,000 psi. The maximum allowable absorption of the concrete shall not exceed 8 percent of the dry weight.

The circumferential reinforcement in the riser sections, conical top sections and base wall sections shall consists of one (1) line of steel and shall be not less than 0.17 square inches per lineal foot.

The ends of each reinforced concrete manhole riser section and the bottom of the manhole top section shall be so formed that when the manhole risers and the top are

assembled, they will make a continuous and uniform manhole.

Joints of the manhole sections shall be of the tongue and groove type. Sections shall be joined using 0-ring rubber gaskets conforming to the applicable provisions of ASTM C443, latest revision, or filled with an approved preformed plastic gasket meeting the requirements of Federal Specifications 55-5-00210, "Sealing Compound, Preformed Plastic for Pipe Joints", Type 1, Rope Form.

Each section of the precast manhole shall have not more than two (2) holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with rubber stoppers or mortar after installation.

Manhole base sections shall be circular, wet cast, and may be supplied in forty-eight (48) inches, sixty (60) inches, seventy-two (72) inches, eighty-four (84) inches, and ninety-six (96) inches diameters. Heights shall range from forty-eight (48) inches to ninety-six (96) inches depending on availability with diameter and as specified or approved by the Engineer. All base sections shall be supplied with Manhole Lift System inserts as manufactured by Press-Seal Gasket Corporation. Lifting eye bolts, also manufactured by Press-Seal Gasket Corporation, shall be supplied to the Contractor upon request. Manhole bases manufactured with pipe openings eighteen (18) inches or less shall be furnished with Kor-N-Seal flexible pipe-to-manhole connectors. Pipes with diameters greater than eighteen (18) inches shall be secured with a concrete cradle installed to the springline of the pipe utilizing Class “B” concrete conforming to he requirements of Section 03300 - Cast-In-Place Concrete.

Riser sections shall be circular, wet or dry cast, and may be supplied in forty-eight (48) inches, sixty (60) inches, seventy-two (72) inches, eighty-four (84) inches and ninety-six (96) inches diameters. Heights shall range from sixteen (16) inches to forty-eight (48) inches in sixteen (16) inch multiples depending on availability with diameter and as specified or approved by the Engineer. All riser sections shall be supplied with Manhole Lift System inserts as manufactured by Press-Seal Gasket Corporation. Lifting eye bolts, also manufacture by Press-Seal Gasket Corporation, shall be supplied to the Contractor upon request.

Transition sections shall be wet or dry cast. Conical transition sections shall be supplied for sixty (60) inches to forty-eight (48) inches diameter transitions. Conical transitions shall be thirty-two (32) inches high. Sixteen (16) inches high conical transitions may only be used when approved by the City. All conical transition sections shall be supplied with a Manhole Lift System as manufactured by Press-Seal Gasket Corporation. Flat slab transitions shall be supplied for base sections seventy-two (72) inches to ninety-six (96) inches in diameter. Flat slab transitions shall be manufactured structurally to meet individual project requirements. Clear access openings shall be provided to accommodate riser sections as shown in the Plans or as detailed in the Detail Drawings.

Conical sections shall be wet or dry cast, eccentric only. Concentric sections will not be allowed. Conical sections shall transition from forty-eight (48) inches diameter to a twenty-four (24) inches clear access opening and be thirty-six (36) inches high. They shall be supplied with a Manhole Lift System as manufactured by Press-Seal Gasket Corporation

Precast manhole riser joints shall be offset tongue and groove type, supplied with Tylox Super Seal pre-lubricated gasket as manufactured by Hamilton Kent. Each joint shall also be supplied with Conseal CS-231 waterstop sealant as manufactured by Concrete Sealants, in widths as recommended by the manufacturer.

The ends of each reinforced concrete manhole riser section and the bottom end of the manhole top section shall be so formed that when the manhole risers and the top are assembled, they will make a continuous uniform manhole.

Standard manholes of precast concrete construction, and other manholes of precast concrete construction having entering sewers of twenty-four (24) inches diameter or smaller shall have precast openings in the manhole walls for incoming or outgoing sewers as indicated on the Plans.

All components of a manhole for a particular location shall be clearly marked in order that the manhole may be correctly assembled to suit construction conditions existing at that particular location.

All precast concrete manhole base sections and drop manhole bases shall be set on a foundation of #57 compacted stone aggregate, twelve (12) inch minimum thickness, and covering the entire bottom of the excavation for the manhole. Aggregate size may be adjusted by the Engineer based on field conditions.

Manhole steps shall conform to the requirements of this section.

2-3.02. A corrosion protection system shall be applied to the interior surfaces of the manhole. The corrosion protection system shall adequately protect the concrete from corrosion caused by exposure to hydrogen sulfide. See Section 09940 Protective Coatings. Information regarding the proposed corrosion protection system shall be submitted to Engineer for review and acceptance.

2-4. JOINTS. All joints shall be slushed with mortar at every course, but slushing alone will not be considered adequate for making an acceptable joint. Exterior faces shall be laid up in advance of backing. Exterior faces shall be back plastered or pargeted with a coat of mortar not less than ¼-inch thick before the backing is laid up.

Prior to pargeting, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than ¼-inch nor more than ½-inch wide and whatever width is adopted shall be maintained uniform throughout the work.

Pointing. Face joints shall be neatly struck, using the weather joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

2-5. CLEANING. Upon completion of the work, all exterior surfaces shall be thoroughly cleaned by scrubbing and washing down with water and, if necessary to produce satisfactory results, cleaning shall be done with a 5 percent solution of muriatic acid which shall then be rinsed off with liberal quantities of clean fresh water.

2-5.01. Curing and cold weather protection. In hot or dry weather the brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost in the brick or when the air temperature is below 50 degrees F unless the Contractor has on the project, ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60 degrees F for the duration of the curing period.

2-6. STRUCTURAL MATERIALS AND CASTINGS. Structural steel shall conform to the requirements of ASTM A283, unless otherwise indicated on the Plans.

Steel castings shall conform to the requirements of ASTM A27. The grades to be used will be specified in the Special Conditions or indicated on the Plans.

Gray iron castings shall conform to the requirements of ASTM A48. All castings shall be clean and free of scale, adhesions, or inclusions. Gray iron castings for manhole or inlet frames and covers or gratings shall be cast from Class 30B cast iron. Bearing surfaces between manholes, inlet frames, and covers or gratings shall be such that the cover or grating shall seat in any position onto the frame without rocking. Bearing surfaces for standard manhole frames and covers shall be machined.

Aluminum castings shall conform to the requirements of ASTM B108.

Structural aluminum shall conform to the requirements of either ASTM B209, B221, B308, B241, or B211, as applicable. Finished bolts and nuts shall be given an anodic coating of at least 0.0002 inches in thickness.

2-7. FRAMES, COVERS, AND STEPS. New manhole rims, toe pockets, frames, and covers shall be cast iron conforming to the requirements of ASTM A48 for Class 30 Gray Iron Castings. All castings shall be made accurately to the required dimensions, fully interchangeable, sound, smooth, clean, and free from blisters or other defects.

Defective castings which have been plugged or otherwise treated shall not be used. All castings shall be thoroughly cleaned and painted or coated with bituminous paint. Each

casting shall have its actual weight in pounds stenciled or painted on it in white paint.

Manhole frames and covers shall be as detailed on the Plans, and as manufactured by Vulcan Foundry, or as manufactured by the Griffin Foundry Co., Russell pipe & Foundry Co., or equal. Manhole covers shall be vented except those located within the one-hundred (100) year flood plain, within three (3) feet of curb for a two (2) lane road, or within the outside lane of a multi-lane road.

Sanitary sewer manhole covers shall have the words cast on the top in letters two (2) inches high per the City Standard Detail.

An adjusting ring shall be provided for each manhole in a street. Provide solid manhole and handhole covers and frames for electrical underground systems. Covers shall have letters "HIGH VOLTAGE", "LOW VOLTAGE", "SIGNAL", as applicable, embossed on top.

Manhole inlet steps shall be made of steel reinforced copolymer polypropylene model PS-1 PF accordance with the City of Atlanta standard details, No. MH-22. They shall be installed at maximum sixteen (16) inch intervals. Manhole steps shall be as shown in the Detail Drawings with rod and pull ratings meeting OSHA standards.

2-8. SPECIALTY ITEMS. One piece manholes shall be manufactured in accordance with the requirements of ASTM C478 and as detailed in the Detail Drawings. They shall be cast utilizing 4000 psi concrete containing type II cement with a C3A content of five and one-half (5½) percent or less. They shall be manufactured within a minimum eight (8) inches thick base with dowel steel reinforcement and waterstop. They shall be used only in situations which will not accommodate a twenty-four (24) inch base section and twenty-four (24) inch conical section.

36” x 48” Manhole Tees shall be manufactured in accordance with the requirements of ASTM C478 and as detailed in the Detail Drawings. They shall be cast utilizing 4000 psi concrete containing type II cement with a C3A content of five and one-half (5½) percent or less.

Saddle manholes shall be manufactured in accordance with the requirements of ASTM C478 and as shown in the Detail Drawings. They shall be cast utilizing 4000 psi concrete containing type II cement with a C3A content of five and one-half (5½) percent or less.

Drop Manholes (Memphis Tees) shall be manufactured in accordance with the requirements of ASTM C478 and as detailed in the Detail Drawings. They shall be cast utilizing 4000 psi concrete containing type II cement with a C3A content of five and one-half (5½) percent or less.

PART 3 - EXECUTION

3-1. CONSTRUCTION OF CAST-IN-PLACE CONCRETE MANHOLES. Cast-in-place manholes, excluding curved manhole bases, shall be constructed in place with the base, barrel, and conical section all monolithically cast using removable forms of material and design approved by the Engineer.

The vertical forms, vertical and horizontal wall spacers, steps and placing cone must be carefully positioned and firmly clamped in place before any placement is made. The wall spacers must be located 90 degrees from each other. The forms shall be firmly supported with bottom of forms at the proper elevation to permit the base to be deposited through the vertical forms.

No pipe penetration shall be formed within 12-inches of a corner, on a square bases, or within 12-inches of another penetration, in any direction, for circular bases.
The manhole base shall be deposited down through the wall forms onto undisturbed earth or shall be rock bearing. It shall be evenly distributed around the walls and vibrated both inside and outside the forms until there is a minimum slope of 60 degrees from the bottom of the forms to the bearing surface both inside and outside of the manhole. When this is complete and before additional concrete is added, the concrete must be carefully vibrated on each side of each sewer pipe.
The base shall be concentric with the manhole, except where eccentric alignment with ladder is required, and have a minimum diameter of 4-feet or 16-inches greater than the outside diameter of the manhole whichever is greater, and 10-inch minimum thickness under the lowest pipe. Minimum wall thickness shall be 6-inches.

Additional concrete must be deposited in evenly distributed layers of approximately 18-inches with each layer vibrated to bond it to the preceding layer. The wall spacers must be raised as the placements are made. The concrete in the area from which the spacer is withdrawn shall be carefully vibrated. Excessive vibration shall be avoided.

Adjustment rings shall be provided between the conical section and the manhole frame. The rings shall be cast-in-place using building felt between pours to create a weakened joint or as directed by the Engineer. If adjustment of the lid elevation is called for, concrete adjusting rings shall be used.

All manhole bases, including curved manhole bases and inverts shall be constructed of Class "A" concrete in accordance with details on the Drawings. Inverts shall be smooth and accurately shaped and have the same cross section as the invert of the sewers which they connect. The manhole base and invert shall be carefully formed to the required size and grade by gradual and even changes in sections, care being exercised to form the incoming and outgoing sewer pipes into the wall of the manhole at the required elevations. Changing directions of flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit. The invert and flow channel shall be formed during or immediately after the placing of the concrete and

brush-finished as soon as the concrete has sufficiently set.

Form marks and offsets shall not exceed 1-inch on the outside surface of the manhole.

Form marks and offsets shall not exceed 1/2-inch inside of the manhole. All offsets on the inside surface of the manhole shall be smoothed and rubbed so there is no projection or irregularity capable of scratching a worker or catching and holding water or other materials. Honeycombed areas shall be completely removed immediately upon removal of the forms and replaced with a Class "A" concrete as directed by the Engineer, or patched with epoxy grout.

Should circumstances make a joint necessary, a formed groove or reinforcing dowels shall be required in the top of the first placement for shear protection. Immediately before the second placement is made, the surface of the cold joint shall be thoroughly cleaned and wetted with a layer of mortar being deposited on the surface.

Concrete setting time and backfilling shall be in accordance with the applicable requirements of Section 03300. Masonry work shall be allowed to set for a period of not less than 24 hours. Outside forms, if any, then shall be removed and the manhole backfilled and compacted. All loose or waste material shall be removed from the interior of the manhole. The manhole cover then shall be placed and the surface in the vicinity of the work cleaned off and left in a neat and orderly condition.

3-2. CONSTRUCTION OF PRECAST CONCRETE MANHOLES. After placing manhole base, inverts shall be constructed using Class "A" concrete and 3 to 5 inches slump range in accordance with details on the Drawings and inverts shall have the same cross section as the invert of the sewers which they connect. The manhole invert shall be carefully formed to the required size and grade by gradual and even changes in sections. Changes in directions of flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit.

After the base section has been set, and inverts formed, the precast manhole sections shall be placed thereon, care being exercised to form the incoming and outgoing sewer pipes into the wall of the manhole at the required elevations.

The cast iron frame for the manhole cover shall be set at the required elevation and properly anchored to the riser section. Where manholes are constructed in paved areas, the top surface of the frame and cover shall be tilted to conform to the exact slope, crown and grade of the existing adjacent pavement.

After backfilling has been completed, the excavated area, if located in a street, alley or sidewalk, shall be provided with a temporary surface.

3-3. MANHOLES OVER EXISTING SEWERS. Construct manholes over existing operating sewer lines at locations shown. Perform necessary excavation as specified

hereinbefore, break into existing line, and construct manhole.

Maintain flow through existing sewer lines at all times, and protect new concrete and mortar work for a period of 7 days after concrete has been placed. Advise Engineer of plans for diverting sewage flow and obtain Engineer's approval before starting. Engineer's approval will not relieve Contractor of responsibility for maintaining adequate capacity for flow at all times and adequately protecting new and existing work.

Construct the new base under the existing sewer and the precast sections as specified herein.

Break out the existing pipe within the new manhole, cover the edges with mortar, and trowel smooth.

3-4. INSPECTION AND TESTING. After completion, all manholes will be inspected. The Contractor shall make, at Contractor's expense, all necessary changes, modifications, and/or adjustments required to assure satisfactory operation.

END OF SECTION

Section 02618

CONCRETE SEWER PIPE

PART 1 - GENERAL

1-1. SCOPE. This section covers bar-cage reinforced concrete pipe with rubber and joints to be furnished for the lines provided in the drawings.

Pipe shall be furnished complete with all jointing materials and other appurtenances.

Pipe trenching, bedding, and backfill are covered in the trenching and backfilling section.

1-2. GOVERNING STANDARDS. Except as modified or supplemented herein, concrete sewer pipe shall comply with ASTM C76 and C655. For metric equivalent pipe, ASTM C76M and C655M shall be used.

1-3. SUBMITTALS. Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not necessarily be limited to, the following for each size and class of pipe:

Data on reinforcement.

Details of joints.

Gasket certificate, certifying that the gasket material is suitable for service intended.

Details of fittings and specials.

Test reports.

Laying schedule.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Concrete pipe and fittings shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces. Use of lifting holes is not acceptable.

PART 2 – PRODUCTS

2-1. BASIS OF DESIGN. Concrete pipe shall be designed to withstand the design loads for the location and depth in the drawings. The minimum D-load value provided shall be 1350-D-load.

Wall thickness shall be not less than Wall B.

The minimum concrete cover over circumferential reinforcement, except under the spigot groove of pipe with concrete spigots, shall be at least 3/4 inch [19 mm] for 54 inch [1300 mm] and smaller pipe, and 1 inch [25 mm] for 60 inch [1500 mm] and larger pipe.

In preparation of concrete pipe layouts, the maximum joint opening shall not exceed 3/8 inch [9.5 mm].

2-2. MATERIALS. Unless otherwise specified, all materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM C76.

Fine Aggregate	ASTM C33.
Cement	ASTM C150, Water-to-cementitious materials ratio of the mortar coating shall not exceed 0.40.
Gaskets	ASTM C361, Section 6.9, gasket. Hardness shall be 40 for concrete joints and 60 for steel joints when measured by ASTM D2240, Type A durometer. Polymer shall be synthetic rubber. Natural rubber will not be acceptable. Gaskets shall be furnished by the pipe manufacturer.
Joint Lubricant	Vegetable based lubricant; petroleum or animal based lubricants will not be acceptable.
Rubber Joint Filler	Synthetic.
Hardness	40 ± 5 as measured by ASTM D2240, Type A durometer.
Tensile Strength	1,200 psi [8 MPa] minimum.

2-3. LENGTH. Except for fittings and closure pieces, each piece of pipe shall be at least 7'-6" [2.2 m] long.

2-4. JOINTS. Except as modified herein, joints shall conform to Section 8 of ASTM C361 and shall consist of a formed concrete bell and spigot and a rubber gasket. Gaskets shall have a circular cross section and shall be confined in a groove in the pipe spigot. Pipe with collars instead of integral bells will not be acceptable.

Each concrete pipe joint shall be designed to withstand the gasket compression, plus a differential load across the joint equal to 4,000 pounds per foot [58 kN/m] of internal diameter, without cracking.

Pipe sections connecting to manholes shall have a joint in each line within 4 feet [1.2 m] of the inside face of each manhole or other structure.

2-5. REINFORCEMENT. Circumferential reinforcement shall be full-circle type. Elliptical or part-circle reinforcement will not be acceptable. The total area of longitudinal steel shall be at least 0.2 percent of the concrete cross-sectional area of the pipe. Longitudinal steel shall be spaced uniformly around the pipe and shall consist of at least eight continuous or lap spliced wires or bars (20 bar diameters for deformed bars or 40 bar diameters for smooth bars) in each cage; splices shall not be welded.

For pipe larger than 72 inches [1800 mm] in diameter, longitudinal bars shall be spaced not more than 30 inches [750 mm] apart.

2-6. FITTINGS. All bends, tees, closure pieces, wall fittings, and other fittings which are indicated on the Drawings or are necessary to complete the work shall be furnished. Except as modified or otherwise provided herein, the design and manufacture of fittings shall be governed by the same requirements as the connecting piping.

2-6.01. Bends. Bends for concrete sewer pipe shall be fabricated in accordance with this paragraph and shall be provided at the locations indicated on the Drawings. Bends shall be fabricated from segments of a steel cylinder, with concrete or mortar lining and reinforced concrete exterior covering. The deflection angle between adjacent segments shall not exceed 30 degrees [0.5 rad].

Steel cylinders for bends shall be at least USS 10 gage [3.42 mm thick] and shall be lined with at least 3/4 inch [19 mm] of mesh-reinforced concrete or mortar. Bends fabricated from steel cylinders shall be designed for the same three-edge bearing loads as the adjacent piping.

2-6.02. Wall Fittings. Wall fittings shall be bell type, and shall be provided at the locations indicated on the Drawings. Wall fittings shall be of the required length, shall have bells to match the joints on the concrete pipe, and shall be fabricated by the manufacturer of the pipe to which they connect.

2-6.03. Outlets. Fabricated outlet branches shall be provided as indicated on the Drawings.

2-6.04. Closure Pieces, Rubber and Concrete Joints. Shop fabricated closure pieces are not required for pipe with rubber and concrete joints. Closure pieces shall be cut in the field after the pipe, fittings, and specials indicated on the Drawings have been installed. The alignment indicated on the Drawings shall be maintained by deflecting joints and by adding fittings if necessary. The length between structures and PI locations shall be adjusted in the field if required.

Closure pieces shall be field cut from full-length pipe sections. At the option of Contractor, field cuts may be made with a masonry saw, or may be chiseled and neatly trimmed. Field-cut ends shall be encased in reinforced collars at least 8 inches [200 mm] thick and extending 18 inches [450 mm] on each side of the field cuts.

2-7. MARKING. Each pipe or fitting shall have the following information plainly and permanently marked thereon:

Pipe class.

Date of manufacture.

Manufacturer's name or trademark.

On bends, the angle of the bend.

Markings shall be indented in the pipe or painted on the pipe with waterproof paint.

2-8. CURING. Prior to delivery to the Site, concrete pipe and fittings shall be cured in the manufacturer’s facilities until concrete control cylinders representing such pipe have attained a compressive strength of at least 80 percent of the specified minimum 28 day strength.

2-9. PRELIMINARY TESTS. All preliminary tests shall be made at Contractor's expense. Reports covering the following joint leakage and shear tests on each size of pipe, and the three-edge bearing and absorption tests on each size and class of pipe, shall be submitted to Engineer for review as indicated.

Joint Leakage	ASTM C443, Section 10.
Joint Shear	Suitable arrangement to apply the specified loads.
Cement (Type II)	Mill test report showing tricalcium aluminate content.
Three-Edge Bearing	ASTM C497, indicating load required

	for 0.01 inch [0.25 mm] crack.
Absorption	ASTM C497.

2-10. CONTROL TESTS. Control tests to determine strength and absorption shall be made during the manufacture of the pipe. The tests shall be made by an independent testing laboratory at the expense of the Contractor.

At the option of Contractor, strength tests may be made on cores or on standard concrete cylinders. A set of two cores or four cylinders shall be taken from each day's production and each time the concrete mix is changed. One-half of the samples shall be tested at 7 days or earlier to determine when the pipe has attained sufficient strength for delivery. The remainder shall be tested at 28 days.

Absorption tests shall be made on cores taken from the pipe barrel. Cores shall be at least 2 inches [50 mm] in diameter and shall be taken with a diamond drill. One core shall be tested from each of the first three lengths of pipe of each size and class. Additional cores shall be tested from 5 percent of the pipe produced, but not less than one from each day's production.

Core holes shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to Engineer.

Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation and testing will be in accordance with the Sewer Pipe Installation and Testing section.

End of Section

Section 02619

CONCRETE CULVERTS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing bar-cage reinforced concrete pipe with rubber O-ring gaskets,flat rubber gaskets, flexible joint sealant, or mastic sealant, for the lines indicated on the Drawings.

Pipe shall be furnished complete with all fittings, specials, jointing materials, and other necessary appurtenances.

Pipe trenching, bedding, and backfill are covered in the Trenching and Backfilling section.

1-2. GOVERNING STANDARD. Except as modified or supplemented herein, the manufacture of concrete culvert pipe shall be governed by ASTM C76.

1-3. SUBMITTALS. Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted in accordance with the Submittals Procdures section. The drawings and data shall include, but shall not be limited to, the following for each size and class of pipe:

Data on reinforcement.

Details of joints.

Details of fittings and specials.

Test reports.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Concrete culvert pipe shall not be delivered to the Site until concrete control cylinders representing such pipe shall have attained a compressive strength of at least 80 percent of the specified minimum 28 day strength.

Concrete pipe and fittings shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces. Use of lifting holes will not be permitted.

PART 2 - PRODUCTS

2-1. BASIS OF DESIGN. The wall thickness of concrete culvert pipe shall be not less than ASTM C76, Wall B.

2-2. MATERIALS. Unless otherwise specified herein, all materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM C76.

Cement	ASTM C150.
Gaskets	ASTM C443. The polymer shall be synthetic rubber; natural rubber will not be acceptable.
Flexible Joint Sealant	Preformed butyl rubber sealant; Hamilton-Kent "Kent-Seal No. 2", Press-Seal Gasket "E-Z Stik", K.T. Snyder "RUB'R-NEK", or Concrete Sealants "Conseal CS102" or "CS202".
Mastic	Trowel grade sewer sealing compound; Grahn "Anchor-Tite Plastic Mastic" or J.P. Petroleum Products "Tex-Mastic 726".
Rubber Joint Filler	Synthetic.
Hardness	40 plus or minus 5 when measured by ASTM D2240, Type A durometer.
Tensile Strength	1,200 psi [8300 kPa] min.

2-3. LENGTH. Except for fittings and closure pieces, each piece of pipe shall have a minimum length of 18 ft.

2-4. JOINTS. Joints shall conform to ASTM C76, and rubber-gasketed joints shall also conform to ASTM C443. Joint design shall be suitable for the joint sealing material to be used.

2-5. REINFORCEMENT. Circumferential reinforcement shall be full-circle type. Elliptical or part-circle reinforcement will not be acceptable. The total area of longitudinal steel shall be not less than 0.2 percent of the concrete cross- sectional area

of Wall B. Longitudinal bars shall be spaced uniformly around the pipe and shall be continuous in each cage. For pipe larger than 72 inches [1800 mm] in diameter, longitudinal bars shall not be spaced more than 30 inches [750 mm] apart.

2-6. FITTINGS AND SPECIALS. All bends, tees, closure pieces, wall fittings, and other fittings which are indicated on the Drawings or necessary to complete the work shall be furnished. Except as modified or otherwise provided herein, the design and manufacture of fittings shall be governed by the same requirements as the connecting piping.

2-6.01. Bends. Bends for concrete culvert pipe shall be fabricated in accordance with this paragraph and shall be provided at the locations indicated on the Drawings. At the option of Contractor, bends shall be fabricated from segments of a steel cylinder, with concrete or mortar lining and reinforced concrete exterior covering, or from segments of concrete pipe miter-cut while the pipe is still green. The deflection angle between adjacent segments shall not exceed 30 degrees [0.5 rad].

Steel cylinders for bends shall be at least USS 10 gage [3.42 mm] thick and shall be lined with at least 3/4 inch [19 mm] of concrete or mortar. Bends fabricated from steel cylinders shall be designed for the same three-edge bearing loads as the adjacent piping.

On bends fabricated from miter-cut segments of green concrete pipe, the concrete shall be removed from around the reinforcing steel as necessary, the steel shall be welded, and the bend shall be re-covered with concrete. After installation, the entire bend shall be encased in concrete. Concrete encasement shall be at least 8 inches [200 mm] thick all around the pipe and shall extend the full length of the bend.

2-6.02. Wall Fittings. Wall fittings shall be bell type, and shall be provided at the locations indicated on the Drawings. Wall fittings shall be of the required length, with bells to match the joints on the concrete pipe.

2-6.03. Outlets. Outlets shall be provided as indicated on the Drawings.

2-6.04. Closure Pieces. Shop fabricated closure pieces are not required. Closure pieces will be cut in the field after all pipe, fittings, and specials indicated on the Drawings have been installed. The alignment indicated on the Drawings will be maintained by deflecting joints and by adding fittings if necessary. The length between structures and PI locations will be adjusted in the field if required.

Closure pieces will be field cut from full-length pipe sections. At the option of the Contractor, field cuts may be made with a masonry saw, or may be chiseled and neatly

trimmed. Field-cut ends will be encased in reinforced collars at least 8 inches [200 mm] thick and extending 18 inches [450 mm] on each side of the field cuts.

2-7. MARKING. Each pipe or fitting shall have plainly and permanently marked thereon:

Pipe class.

Date of manufacture.

Manufacturer's name or trademark.

On bends, the angle turned thereby.

Identification of specials to show the location in the line.

Markings shall be indented in the pipe or painted thereon with waterproof paint.

2-8. PRELIMINARY TESTS. All preliminary tests shall be made at Contractor's expense. Reports covering the following tests on each size and class of pipe shall be submitted to Engineer for review:

Cement	Mill test report showing tricalcium aluminate content, when a limit is specified herein.
Three-Edge Bearing	ASTM C497, indicating load required for the 0.01 inch [0.25 mm] crack.
Absorption	ASTM C497.

The three-edge bearing test is for proof of design only. It is not required that a test be made on pipe manufactured specifically for this contract. Reports covering tests made on other pipes of the same size, class, and design as specified herein, and manufactured from materials of equivalent type and quality, may be acceptable.

2-9. CONTROL TESTS. Control tests to determine strength and absorption shall be made during the manufacture of the pipe.

The tests shall be made by an independent testing laboratory at the expense of the Contractor. At the option of Contractor, strength tests may be made on cores or on standard concrete cylinders. A set of two cores or four cylinders shall be taken from each day's production and each time the concrete mix is changed. One-half of the samples shall be tested at 7 days or earlier to determine when the pipe has attained sufficient strength for delivery. The remainder shall be tested at 28 days.

Absorption tests shall be made on cores taken from the pipe barrel. Cores shall be at least 2 inches [50 mm] in diameter and shall be taken with a diamond drill. One core shall be tested from each day's production and each time the concrete mix is changed.

Core holes shall be filled by Contractor using concrete plugs cemented in place with an epoxy adhesive or by other methods acceptable to Engineer.

Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

PART 3 - EXECUTION

3-1. INSTALLATION AND TESTING. Installation and testing shall be in accordance with Sewer Pipe Installation and Testing section.

End of Section

SECTION 02650

TESTING FOR ACCEPTANCE OF SANITARY AND STORM SEWERS

PART 1 - GENERAL

1-1. SCOPE. This section includes sanitary sewers inspection and testing methods; joint testing procedures; manhole testing methods; allowable testing limits for sanitary sewers; and any other similar, incidental, or appurtenant operation which may be necessary to properly complete the Work.

The Contractor shall provide all services, labor, materials, and equipment required for all sanitary sewers testing and related operations necessary or convenient to the Contractor for furnishing a complete Work as shown on the Plans or specified in these Specifications.

1-1.01. Related Work Specified Elsewhere:

1. Section 01200 - Measurement and Payment
2. Section 02537 – Ductile Iron Sanitary Sewer Pipe and Fittings
3. Section 02607 – Manholes, Junction Boxes, Catch Basins and Inlets

1-2. SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

1-3. QUALITY ASSURANCE. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

1. American Standards for Testing and Materials (ASTM).

1-4. GENERAL. Upon completion of all or a part of a sanitary sewer line installation, the Contractor shall test and/or inspect the sewer for acceptability. The method(s) of testing and/or inspection shall be as specified in the individual Specifications sections or the Special Conditions. Testing and inspection shall be performed in accordance with the requirements of this section.

One or more of the following tests and/or inspections may be required:

1. Exfiltration of water.
2. Infiltration of water.
3. Exfiltration of air under pressure.
4. Joint testing.
5. Direct visual inspection.
6. Deflection testing.
7. Closed Circuit Television Inspection (CCTV).

The testing method for individual projects shall be as specified in the Special Conditions.

Prior to any testing, all lines shall be cleaned of debris and flushed clean. Debris shall be caught and removed from the line and shall not be flushed into existing live sanitary sewers.

1-5. TEST SECTIONS. Unless otherwise specified or directed by the Engineer, each section of sanitary sewer between manholes shall be tested by the air testing method. The Contractor will be permitted to install a maximum of 1200 feet of sewer prior to performing air testing.

The Contractor may at his option divide the first section of sewer into subsections of more convenient length for testing. If the section or subsection tested does not pass the tests, it shall be repaired and the test repeated until a satisfactory test is obtained. Excavation shall not proceed beyond the first 1200-foot section until test results for the entire 1200 feet are satisfactory.

The Engineer may allow alternate testing methods at his discretion or require additional testing methods if, in his opinion, they are warranted.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3-1. SANITARY AND STORM SEWERS INSPECTION AND TESTING METHODS

3-1.01. All Testing Methods: All wyes, tees, and stubs shall be plugged with flexible jointed caps, or acceptable alternate, and securely fastened to withstand the internal test pressure. Such plugs or caps shall be readily removable.

3-1.02. The Contractor shall clean and test lines before requesting final acceptance. Where any obstruction is met, the Contractor shall clean the sewers by means of rods, swabs, or other instruments. When requested by the Engineer, the Contractor shall flush out lines and manholes before final inspection.

3-1.03. Alignment: Pipe lines shall be straight and show a uniform grade between manholes, except for curves specifically shown on the Plans. The Contractor shall correct any discrepancies discovered during inspection.

3-1.04. Watertightness: All sewers constructed shall be tested for watertightness to the maximum extent feasible. Infiltration and exfiltration tests shall be performed on all new sewers constructed as specified in this section, except for those new sewers constructed which have active services tied into them as the pipe is being installed. In such cases the watertightness of the sewers less than or equal to thirty-six (36) inches shall be based on a visual inspection, and for sewers forty-two (42)inches and larger based on the individual joint test as specified in this section. All visible leaks, including those found via television inspection, shall be repaired.

3-1.05. Infiltration Tests: The Contractor shall install suitable weirs in manholes selected by the Engineer to determine the leakage of ground water into the sewer. The maximum length of line for each infiltration test shall be five-thousand (5,000) feet. The Contractor shall install weirs for a minimum of four hours before measuring flow. If leakage in any section of the sewer line exceeds fifty (50) gpd/inch diameter/mile, the Contractor shall locate and repair leaks. Repair methods must be approved by the Engineer. After repairs are completed, the Contractor shall re-test for leakage. Infiltration testing shall be performed before sanitary sewer lateral reconnections are made.

The Contractor shall furnish, install, and remove the necessary weirs, plugs, and bulkheads required to perform the leakage tests.

Weirs shall be V-notch type equal to Pollard (800/437-1146).

3-1.06. Exfiltration Tests: Low-Pressure Air Test: Sewer diameters less than or equal to twenty-four (24) inches:

Prior to air testing, the section of sewer between manholes shall be thoroughly cleaned and wetted. Immediately after cleaning or while the pipe is water soaked, the sewer shall be tested with low-pressure air. At the Contractor's option, sewers may be tested in lengths between manholes or in short sections (twenty-five [25] feet or less) using inflatable balls pulled through the line from manhole to manhole. Air shall be slowly supplied to the plugged sewer section until internal air pressure reaches approximately four (4) psi. After this pressure is reached and the pressure allowed to stabilize (approximately two (2) to five (5) minutes), the pressure may be reduced to three and one-half (3.5) psi before starting the test. If the pressure drop is equal to or less than one (1) psi during the test time, then the line will be considered as having passed the test. If the pressure drops more than one (1) psi during the test time, the line will be presumed to have failed the test, and the Contractor shall be required to locate the failure, make necessary repairs, and retest the line. Minimum test time for various pipe sizes and types is as follows:

Nominal Pipe Size, inches	Time (Min/100 feet)	
	VCP, RCP	DIP, PVC
6	0.7	5.7

8	1.2	7.6
10	1.5	9.4
12	1.8	11.3
15	2.1	14.2
18	2.4	17.0
21	3.0	19.8
24	3.6	22.8
30	*	35.4
36	*	51.2

* For pipe diameters greater than 24 inch check with manufacturer

Required test equipment, including inflatable balls, braces, air hose, air source, time, rotameter as applicable, cut-off valves, pressure reducing valve, 0-15 psi pressure gauge, 0-5 psi pressure gauge with gradations in 0.1 psi and accuracy of ± two (2) percent, shall be provided by the Contractor. Testing equipment shall be equal to Cherne Air-Loc Testing Systems.

The Contractor shall keep records of all tests made. Copies of such records shall be given to the Engineer or the City. Such records shall show date, line number and stations, operator, and such other pertinent information as required by the Engineer.

The Contractor is cautioned to observe proper safety precautions in the performance of the air testing. It is imperative that plugs be properly secured and that care be exercised in their removal. Every precaution shall be taken to avoid the possibility of over-pressurizing the sewer line.

Individual Joint Test: Pipe joints for sewers thirty (30) inches in diameter and larger shall be air tested individually. The joint tester assembly shall be placed over the joint and the joint area pressurized to four (4) psi. The pressure shall not drop more than two (2) psi in ten (10) seconds. The joint tester assembly shall be equal to Cherne Industries, Inc.

3-1.07. Smoke Testing: Smoke testing may be used only to locate leaks and in no case shall be considered conclusive or a substitute for air tests, exfiltration tests, or infiltration tests. In all cases a smoke test shall be accompanied by an air test, exfiltration test, or infiltration test. The Engineer may order a smoke test if another leakage test fails and the source of the leak cannot be determined by other means. Smoke testing may only be performed where ground water is low. Smoke shall be blown into a sealed section of sewer under pressure and the Contractor and Engineer shall observe for any smoke appearing on top of the ground indicating the presence of leaks.

The Engineer may require that the Contractor excavate the sewer to determine the source of any smoke appearing during the smoke test. All leaks or breaks discovered by the smoke tests shall be repaired and/or corrected by the Contractor at his own expense in a manner acceptable to the Engineer. Equipment and supplies required for smoke tests shall be furnished by the Contractor. The Contractor may perform smoke tests at any time during construction at his option; however, any such tests shall not supplant the final test of the completed work.

3-1.08. Dye Testing: Dye testing may be used only to confirm service connection or disconnection and in no case shall be considered conclusive or a substitute for air tests, exfiltration tests, or infiltration tests. Dye testing may only be performed where ground water is low. Dye shall be introduced into the service lateral and the Contractor and Engineer shall observe for any dye appearing on combined or sanitary sewers. Equipment and supplies required for dye tests shall be furnished by the Contractor. The Contractor may conduct dye tests at any time during construction at his option; however, any such tests shall not supplant the final test of the completed work.

3-1.09. Deflection Test: All PVC gravity sewers:

The Contractor shall test PVC gravity sewers for excessive deflection by passing a mandrel through the pipe. Deflection of the pipe shall not exceed five (5) percent.

The mandrel size shall be based upon the maximum possible inside diameter for the type of pipe being tested, taking into account the allowable manufacturing tolerances of the pipe. The mandrel shall be configured as shown on the Plans and shall have an odd number of legs, or vanes, with a quantity equal to or greater than nine (9). The legs of the mandrel shall be permanently attached to the mandrel. A mandrel with variable sizes shall not be allowed.

The mandrel shall be constructed of steel, aluminum, or other material approved by the Engineer, and shall have sufficient rigidity so the legs of the mandrel will not deform when pulling through a pipe. The Contractor shall provide a proving ring for each size mandrel, with a tolerance of no more than 0.02 inch clearance, and the mandrel dimensions shall be checked by the Engineer, using this proving ring, before use by the Contractor.

The Contractor shall excavate and install properly any section of pipe not passing this test and re-test until results are satisfactory.

This test shall be performed twice:

a. Once within the first thirty (30) days of installation, and

b. Once during final inspection, but no sooner than thirty (30) days after pavement backfill is done, at the completion of this Contract.

3-1.10. Closed Circuit Television Inspection: The Engineer may require that the interior of a new gravity sewer be subjected to a televised inspection. Such internal inspection shall be conducted and documented in accordance with the requirements of Section 02655 - Sanitary Sewer System Cleaning and Television Inspection. Prior to Final Acceptance the City shall be provided with one copy of the TV inspection report and CD-ROMs showing the entire length of the gravity sewer tested. The report shall contain the condition of pipe, type of pipe, depth, location of services, length, type of joints, roundness, and distance between manholes. Any pipe found to be cracked, leaking, misaligned, bellied, or otherwise defective shall be removed and replaced.

3-2. JOINT TESTING PROCEDURES

3-2.01. Joint Testing Procedures: Each sanitary sewer joint shall be individually air tested using a packer or other approved testing device at a test pressure of four (4) psi plus one-half (½) psi per vertical foot of pipe depth up to a maximum of ten (10) psi. The packer or testing device shall be positioned within the sanitary sewer so as to straddle the joint to be tested. The ends of the packer or testing device shall be expanded to isolate the pipe joint from the remainder of the sewer and create a void space between the packer or testing device and the pipe joint. The air shall then be introduced into the void space until the required test pressure is recorded on the void pressure meter. If the required test pressure cannot be developed, the joint will have failed the test. After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the void pressure drops by more than two (2) psi within fifteen (15) seconds, the joint will have failed the test.

All test monitoring shall be above ground and in a location to allow for simultaneous and continuous observation by the Engineer. The void pressure data shall be transmitted electronically from the void to the monitoring equipment

Prior to starting the sanitary sewer joint testing, a two (2) part control test shall be performed as follows:

A demonstration test shall be performed in a test cylinder constructed in such a manner that a minimum of three (3) known leak sizes (0.062, 0.094, 0.125 inch diameter) can be simulated. During the demonstration test, the Contractor shall use a Test Cylinder Gauge to measure void pressure. The Contractor shall also install the void pressure monitoring equipment in the same manner as will be done to measure the void pressure at a sanitary sewer joint. The Contractor shall then apply pressure to the void space.

During the demonstration test, the void pressure reading on the Test Cylinder Gauge shall be the same as that observed on the void pressure monitoring equipment at all times during the test. If the pressure reading on the Test Cylinder Gauge is not the same as the pressure reading observed on the void pressure monitoring equipment at all times, the Contractor shall repair or otherwise modify the packer or testing device and perform the test until the results are satisfactory to the Engineer. The demonstration test may be required, by the Engineer, at any other time during the joint testing work.

Upon entering each manhole to manhole section with the test equipment, but prior to the commencement of joint testing, the packer or testing device shall be positioned on a section of sound sanitary sewer between pipe joints. The Contractor shall then perform the test at the required pressure. If the test indicates that the sanitary sewer will not meet the joint test requirements, the Contractor shall inform the Engineer who will have the discretion of modifying the joint test requirements.

During the sanitary sewer joint testing work, the Contractor shall keep the following records:

a. Manhole to manhole section tested.
b. Test pressure used.
c. Location (footage) of each joint tested.
d. Test results for each joint tested.

3-2.02. Lamping Procedures: Lamping will be performed on all sewer pipeline by the Engineer.

3-3. MANHOLE TESTING METHODS

3-3.01. All rehabilitated manholes. Manhole inserts, new manholes, and replacement manholes shall be tested by the Contractor using the vacuum test method, following the manufacturer's recommendations for proper and safe procedures. Vacuum testing of manholes and structures shall be performed after curing of linings and installation of inserts. Any leakage in the manhole or structure, before, during, or after the test shall be repaired.

3-3.02. Manholes: Prior to testing manholes for watertightness, all liftholes shall be plugged with a non-shrink grout, all joints between precast sections shall be properly sealed and all pipe openings shall be temporarily plugged and properly braced.

Vacuum Tests: The manhole, after proper preparation as noted above, shall be vacuum tested prior to or after backfilling.

If tested prior to backfill, the test shall conform to ASTM C1244 as follows. The test head shall be placed at the inside of the top of the cone section and the compression head inflated to 40 psi to effect a seal between the vacuum base and the manhole structure. The Contractor shall connect the vacuum pump to the outlet port with the valve open. A vacuum of ten (10) inches of mercury [five (5) psi] shall be drawn and the

vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to nine (9) inches [four and one-half (4.5) psi]. The manhole shall be considered as having passed the vacuum test if the time is greater than that specified in the table below. If the manhole fails the initial test, necessary repairs shall be made with non-shrink grout. Retesting shall proceed until a satisfactory test is obtained.

If tested after backfill, the procedure shall be modified per NPCA guidelines (see www.precast.org).

Vacuum testing equipment shall be equal to that as manufactured by P.A. Glazier, Inc.

MINIMUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS AND DEPTHS			
Depth (feet)	Diameter, feet Test Time, seconds		
	4	5	6
8	20	28	33
10	25	33	41
12	30	39	49
14	35	48	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

3-3.03. The City reserves the right to have third party consultants perform construction materials testing and assessments to any new manhole.

3-4. ALLOWABLE TESTING LIMITS FOR SANITARY SEWERS

No Infiltration and exfiltration of ground water or other leakage into or out of the sewer shall be allowed during the twenty-four (24) hour test period.

Any visible or audible leaks into the sewer that can be located shall be repaired or corrected as directed by the Engineer.

Air leakage tests shall be performed in accordance with the requirements of ASTM C828.

End of Section

SECTION 02665

WATER MAINS AND ACCESSORIES

PART I - GENERAL

1-1. SCOPE. Furnish all labor, materials, equipment and incidentals required for the complete installation of water mains and accessories as shown on the Drawings and as specified herein. Work also includes the hydraulic testing and disinfection of the completed water mains after installation.

This Section includes ductile iron pipe and fittings ranging in size from 4-inches in diameter through 64-inches in diameter.

Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), or other recognized standards. Latest revisions of all standards are applicable.

Galvanized pipe and fittings shall not be used as any part of the Water Transmission and Distribution System, nor shall it be used to join any appurtenances to the System.

1-2. QUALITY ASSURANCE. Reference Standards: The design, manufacturing and assembly of elements of the products herein specified shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or otherwise specified.

ANSI/AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

ANSI/AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.

ANSI/AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

ANSI/AWWA C115/A21.15 – Flanged Ductile-Iron Pipe with Ductile- Iron or Gray Iron Threaded Flanges

ANSI/AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe

ANSI/AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast
ANSI/AWWA C153/A21.53 – Ductile-Iron Compact Fittings for Water Service

ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

ANSI /AWS D11.2 – Guide for Welding Iron Castings

AWWA C651 – Disinfecting Water Mains

1-3. SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

Product data and engineering data, including shop drawings.

Evidence that manufacturers have consistently produced products of satisfactory quality and performance for a period of at least two (2) years.

Written certification that all products furnished comply with all applicable requirements of these specifications.

For pipe 24-inches in diameter or greater, submit shop drawings to the Engineer for review showing a complete laying plan of all pipe, including all fittings, adapters, valves and specials along with the manufacturer's drawings and specifications indicating complete details of all items. The pipe details shall include stationing, pipe class or design and supporting computations; and laying schedule which specifies pipe class, class coding, pipe stationing for all changes in grade or horizontal alignment, transition stations for various pipe classes and the limits of each reach of restrained joint pipe.

The above shall be submitted to the Engineer for review before fabrication and shipment of these items.

1-4. TRANSPORTATION AND HANDLING. Unloading: Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings and accessories. Make equipment available at all times for use in unloading. Do not drop or dump materials. Any materials dropped or dumped will be subject to rejection without additional justification. Pipe handled on skids shall not be rolled or skidded against the pipe on the ground.

Handling: Handle pipe, fittings, and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift, or front end loader. Do not use material damaged in handling. Slings, hooks or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior coatings or internal lining of the pipe.

1-5. STORAGE AND PROTECTION. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.
Stored materials shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

Pipe shall not be stacked higher than the limits recommended by the manufacturer.

The bottom tier shall be kept off the ground on timbers, rails or concrete. Pipe in tiers shall be alternated: bell, plain end; bell, plain end. At least two rows of timbers shall be placed between tiers and chocks, affixed to each other in order to prevent movement. The timbers shall be large enough to prevent contact between the pipe in adjacent tiers.

Stored mechanical and push-on joint gaskets shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

Mechanical joint bolts shall be handled and stored in such a manner that will ensure proper use with respect to types and sizes.

1-6. WATER MAIN LOCATION. The minimum depth of cover over the pipe shall be four (4) feet and the maximum cover shall be five (5) feet. Any deviations must be approved by the Engineer.

The installation of the water main parallel to another utility in the same vertical plane is not permitted, i.e., “stacking of utilities is not permitted.

PART 2 – PRODUCTS

2-1. DUCTILE IRON PIPE. Ductile iron pipe shall be manufactured in accordance with ANSI/AWWA C151/A21.51. All pipe, except specials, shall be furnished in nominal lengths of 18 to 20 feet. Sizes will be as shown on the Drawings. All pipe shall have a minimum pressure rating as indicated in the following table and corresponding minimum wall thickness, unless otherwise specified or shown on the Drawings:

Pipe Sizes (inches)	Pressure Class (psi)
4 - 12	350
14 - 18	350
20	300
24	250
30 - 54	200
60 - 64	200

Flanged pipe minimum wall thickness shall be equal to Special Class 53. Flanges shall be furnished by the pipe manufacturer.

Fittings shall be ductile iron and shall conform to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 with a minimum rated working pressure of 250 psi.

2-1.01. Joints: Unless shown or specified otherwise, joints shall be push-on or restrained joint type for pipe and standard mechanical, push-on or restrained joints for fittings. Push-on and mechanical joints shall conform to ANSI/AWWA C111/A21.11.

The only acceptable restrained joint systems are identified in the table below. No field welding of restrained joint pipe will be allowed.

Acceptable Restrained Joints				
Pipe Dia. (in.)	ACIPCO	U.S. Pipe	McWane	Generic*
4 – 12	Fast-Grip Flex Ring	Field Lok TR Flex	Push-On Restrained Joint Type A	MJ with Retainer Gland
16 – 24	Fast-Grip Flex Ring	Field Lok TR Flex	Push-On Restrained Joint Type A	MJ with Retainer Gland
30 – 36	Flex Ring	TR Flex	Push-On Restrained Joint Type B	MJ with Retainer Gland
42 – 48	Flex-Ring	TR Flex	N/A	MJ with Retainer Gland
54 – 64	Lok-Ring	TR Flex	N/A	N/A

Fittings and valves only, and only where specifically allowed.

Restrained joint pipe (RJP) on supports shall have bolted joints and shall be specifically designed for clear spans of at least 36 feet.

Flanged joints shall meet the requirements of ANSI B16.1, Class 125.

2-1.02. Gaskets: Gaskets for the various types of joints shall be as follows:

Gaskets for mechanical joints shall be made of vulcanized styrene butadiene (SBR) as specified in ANSI/AWWA C111/A21.11 unless specified otherwise. Reclaimed or natural rubber shall not be used. Gaskets shall be free from porous areas, foreign material and other defects that make them unfit for the use intended.

Gaskets for flanged joints shall be made of synthetic rubber, ring type or full face type and shall be 1/8-inch thick. Gaskets shall conform to the dimensions specified in ANSI/AWWA C111/A21.11.

Gaskets for push-on and restrained joints shall be in accordance with the pipe manufacturer's design dimensions and tolerances. Gaskets shall be made of vulcanized styrene butadiene (SBR) as specified in ANSI/AWWA C111/A21.11 unless specified otherwise.

2-1.03. Bolts and Nuts: Provide the necessary bolts for connections. All bolts and nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A external and 2B internal fit.

Bolts and nuts for mechanical joints shall be tee head bolts and nuts of high- strength low-alloy steel having a minimum yield strength of 45,000 psi. Dimensions of bolts and nuts shall be in accordance with the dimensions shown in ANSI/AWWA C111/ A21.11.

Flanged joints shall be bolted with through stud or tap bolts of required size as directed. Bolt length and diameter shall conform to ANSI/AWWA C115 for Class 125 flanges shown in ANSI/ASME B16.1.

Bolts for exposed service shall be zinc plated, cold pressed, steel machine bolts conforming to ASTM A307, Grade B. Nuts for exposed service shall be zinc plated, heavy hex conforming to ASTM A563. Zinc plating shall conform to ASTM B633, Type II.

Bolts for submerged service shall be stainless steel machine bolts conforming to ASTM A193, Grade B8. Nuts shall be heavy hex, stainless steel conforming to ASTM A194, Grade 8.

Mechanical joint glands shall be ductile iron.

Welded Outlets: Welded outlets may be provided in lieu of tees or saddles on mains with a diameter greater than or equal to 24-inches. The pipe joint on the outlet pipe shall meet the joint requirements specified above. The minimum pipe wall thickness of the parent pipe and the outlet pipe shall be Special Thickness Class 53 (Pressure Class 350 for 60 and 64-inch sizes). The welded outlet shall be rated for 250 psi working pressure. Each welded outlet shall be hydrostatically tested at 500 psi. The welded outlet shall be fabricated by the manufacturer of the parent pipe. The maximum outlet diameters shall not exceed those listed in the table below:

Parent Pipe Diameter, Inches	Maximum Outlet Diameter, Inches
24	16
30	20
36	24
42	30
48	30
54	30
60	30
64	30

Thrust collars shall be welded-on ductile iron body type designed to withstand thrust due to 250 psi internal pressure on a dead end from either direction on that pipe size. The thrust collars shall be continuously welded to the pipe by the pipe manufacturer.

Solid sleeves shall be used to connect plain end ductile iron pipe. Solid sleeves shall meet the requirements of ANSI/AWWA C110/A21.10 for long pattern and have a minimum pressure rating of 250 psi. Solid sleeves shall have mechanical or restrained joints as specified in this section or as shown on the Drawings. Solid sleeves shall be used only in locations shown on the Drawings or at the discretion of the Engineer. Solid sleeves shall be manufactured by American Cast Iron Pipe Company or U. S. Pipe.

Pipe stubs for all structure connections shall not exceed 2-feet in length. Caps shall be furnished where required.

2-1.04. Cement Lining: Interior surfaces of all ductile iron pipe and fittings shall be cleaned and lined with a cement mortar lining applied in conformity with ANSI/AWWA C104/A21.4. If lining is damaged or found faulty upon delivery, the damaged pipe sections shall be repaired or removed from the site as directed by the Engineer.

Lining thickness: The minimum lining thickness shall be as shown in the following table. Lining shall be square and uniform with regard to the longitudinal axis of the pipe.

Pipe Diameter (Inches)	Minimum Lining Thickness (Inches)

3 - 12	1/8
14 - 24	3/32
30 - 64	1/8

2-1.05. Pipe Coating: Unless otherwise specified, pipe and fittings shall be coated with a 1 mil asphaltic coating as specified in ANSI/AWWA C151/A21.51.

2-1.06. Polyethylene Encasement: Ductile iron pipe shall be encased with polyethylene film where shown on the Drawings, specified or directed by the Engineer. Polyethylene film shall be as specified in Section 02616.

2-1.07. Pipe Insulation: Where a water main is exposed to the elements because the pipe is above ground, the Engineer shall determine whether the pipe is to be insulated or not. Where insulation is to be furnished and installed it shall conform to the following:

1. Insulating material shall be 3-inch thick polyurethane pipe covering formed to fit the pipe diameter.

2. Outer covering shall be 0.016-inch thick aluminum chiller jacket with moisture shield and secured with stainless steel wire or stainless steel straps.

Acceptance will be on the basis of the Engineer's inspection and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

2-2. PIPING APPURTENANCES

2-2.01. Mechanical Joint Restraint

1. Design: Restraint devices for pipe sizes 3 inches through 48 inches in diameter shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.

   The devices shall have a working pressure rating of 350 psi for 3-16 inch diameter pipe and 250 psi for 18-48 inch diameter pipe. Ratings are for water pressure and shall include a minimum safety factor of 2 to 1 in all sizes.

2. Material: Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.

   Ductile iron gripping wedges shall be contoured to fit on the pipe and shall be heat treated within a range of 370 to 470 BHN.

Dimensions of the glands shall be such that they can be used with the standard mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C 153/A21.53, latest editions.

3. Approvals: Restraint devices shall be listed by Underwriters Laboratories (3-inch through 24-inch size) and approved by Factory Mutual (3-inch through 12-inch size).

   Mechanical joint restraint shall be Megalug Series 1100 as manufactured by EBAA Iron Inc., Uni-Flange Series 1400, as manufactured by Ford Meter Box Company or approved equal.

2-2.02. Hydrant Connections:

1. Pipe: Pipe shall have mechanical joint ends and be as specified in paragraph 2.02 of this Section.

2. Hydrant Tees: Hydrant tees shall conform to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. Tapping saddles shall not be allowed.

2-2.03. Anchor Couplings: Anchor couplings for hydrant installation shall be class 350 ductile iron pipe meeting the requirements of AWWA C151/ANSI A21.51, Class 53 and shall have an anchoring feature at both ends so that when used with mechanical joint split glands a restrained joint is provided.

Anchor couplings shall be cement lined in accordance with ANSI/AWWA C104/ A21.4 and shall have a bituminous coating in accordance with ANSI/AWWA C151/A21.51.

Anchor couplings shall be equal to swivel anchor pipe and couplings as manufactured by Fab Pipe, Inc., Tyler Utilities Division of Union Foundry Company or approved equal.

2-2.04. Hydrant Connector Pipe: Hydrant connector pipe shall be class 350 ductile iron meeting the requirements of ANSI/AWWA C153/A21.53 and shall be offset design so that the hydrant can be adjusted to ensure placement at the proper grade. Connector pipe shall have an anchoring feature at both ends so that when used with mechanical joint split glands a restrained joint is provided.

Hydrant connector pipe shall be cement lined in accordance with ANSI/AWWA C104/ A21.4 and have a bituminous coating in accordance with ANSI/AWWA C151/A21.51.

Hydrant connector pipe shall be equal to the Gradelok as manufactured by Assured Flow Sales, Inc., Sarasota, Florida.

Hydrant connector pipe shall not be used unless specifically directed by the Engineer.

2-2.05. Tapping Saddles: Tapping saddles are not allowed.

2-2.06. Detection Tape: Detection tape shall be composed of a solid aluminum foil encased in a protective plastic jacket. Tapes shall be color coded in accordance with APWA color codes with the following legends: Water Systems, Safety Precaution Blue, "Caution Water Line Buried Below". Colors may be solid or striped. Tape shall be permanently printed with no surface printing allowed. Tape width shall be a minimum of 2-inches when buried less than 10-inches below the surface. Tape width shall be a minimum of 3-inches when buried greater than 10-inches and less than 20-inches. Detection tape shall be equal to Lineguard Type III Detectable or Allen Systems Detectatape.

PART 3 - EXECUTION

3-11. LAYING AND JOINTING PIPE AND ACCESSORIES. Lay all pipe and fittings to accurately conform to the lines and grades as shown on the Drawings or as established by the Engineer.

3-1.01. Pipe Installation: Proper equipment, tools and facilities shall be provided for the safe performance of the Work. All pipe, fittings, valves and hydrants shall be lowered carefully into the trench by means of slings, ropes or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench.

All pipe, fittings, valves, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.

All lumps, blisters and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and free from dirt, sand, grit or any foreign materials before the pipe is laid. No pipe containing dirt shall be laid.

Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing or other materials shall be placed in the pipe at any time.

As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.

It is not mandatory to lay pipe with the bells facing the direction in which work is progressing.

Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade, shall not be permitted.

Provide detection tape for all pipe greater than 12-inches in diameter. Detection tape shall be buried 4 to 10-inches deep. Should detection tape need to be installed deeper, the Contractor shall provide 3-inch wide tape. In no case shall detection tape be buried greater than 20-inches from the finish grade surface.

3-1.02. Alignment and Gradient: Lay pipe straight in alignment and gradient or follow true curves as nearly as practicable. Do not deflect any joint more than the maximum deflection recommended by the manufacturer.

Maintain a transit, level and accessories at the work site to lay out angles and ensure that deflection allowances are not exceeded.

Expediting of Work: Excavate, lay the pipe, and backfill as closely together as possible. Do not leave unjointed pipe in the trench overnight. Backfill and compact the trench as soon as possible after laying and jointing is completed. Cover the exposed end of the installed pipe each day at the close of work and at all other times when work is not in progress. If necessary to backfill over the end of an uncompleted pipe or accessory, close the end with a suitable plug, either push-on, mechanical joint, restrained joint or as approved by the Engineer.

3-1.03. Joint Assembly: Push-on, mechanical, flange and restrained type joints shall be assembled in accordance with the manufacturer's recommendations.
The Contractor shall inspect each pipe joint within 1,000 feet on either side of main line valves to insure 100 percent seating of the pipe spigot, except as noted otherwise.

Each restrained joint shall be inspected by the Contractor to ensure that it has been “homed” 100 percent.

The Contractor shall internally inspect each pipe joint to insure proper assembly for pipe 24-inches in diameter and larger after the pipe has been brought to final alignment.

3-1.04. Cutting Pipe: The Contractor shall cut the pipe and bevel the end, as necessary, to provide the correct length of pipe necessary for installing the fittings, valves, accessories and closure pieces in the correct location. Only push-on or mechanical joint pipe shall be cut. Cement lining shall be undamaged.

3-1.05. Polyethylene Encasement: Installation shall be in accordance with ANSI/AWWA C105/A21.5 and the manufacturer's instructions. All ends shall be securely closed with tape and all damaged areas shall be completely repaired to the satisfaction of the Engineer.

3-2. CONNECTIONS TO WATER MAINS. Make connections to existing pipe lines with tapping sleeves and valves, unless specifically shown otherwise on the Drawings.

3-2.01. Location: Before laying pipe, locate the points of connection to existing water mains and uncover as necessary for the Engineer to confirm the nature of the connection to be made.

3-1.02. Interruption of Services: Make connections to existing water mains only when system operations permit and only when notices are issued to the customer. The Contractor will operate existing valves only with the specific authorization and direct supervision of the Owner.

3-2.03. Tapping Sleeves: Holes in the new pipe shall be machine cut, either in the field or at the factory. No torch cutting of holes shall be permitted.

Prior to attaching sleeve, the pipe shall be thoroughly cleaned utilizing a brush and rag as required.

Before performing field machine cut, the watertightness of the sleeve assembly shall be pressure tested. The interior of the assembly shall be filled with water. An air compressor shall be attached, which will induce a test pressure as specified in this Section. No leakage shall be permitted for a period of five minutes.

After attaching the sleeve to an existing main, but prior to making the tap, the interior of the assembly shall be disinfected. All surfaces to be exposed to potable water shall be swabbed or sprayed with a one percent hypochlorite solution.

Connections using Solid Sleeves: Where connections are shown on the Drawings using solid sleeves, the Contractor shall furnish materials and labor necessary to make the connection to the pipe line including cutting, excavation and backfill.

Connections Using Couplings: Where connections are shown on the Drawings using couplings, the Contractor shall furnish materials and labor necessary to make the connection to the existing pipe line, including all necessary cutting, excavation and backfill.

3-3. THRUST RESTRAINT. Provide restraint at all points where hydraulic thrust may develop.

3-3.01. Retainer Glands: Provide retainer glands where shown on the Drawings. Retainer glands shall be installed in accordance with the manufacturer's recommendations, particularly, the required torque of the set screws. The Contractor shall furnish a torque wrench to verify the torque on all set screws which do not have inherent torque

3-3.02. Harnessing: Provide harness rods only where specifically shown on the Drawings or directed by the Engineer.

Harness rods shall be manufactured in accordance with ASTM A36 and shall have an allowable tensile stress of no less than 22,000 psi. Harness rods shall be hot dip galvanized or field coated with bitumastic before backfilling.
Where possible, harness rods shall be installed through the mechanical joint bolt holes.

Where it is not possible, provide 90 degree bend eye bolts.

Eye bolts shall be of the same diameter as specified in ANSI/AWWA C111/A21.11 for that pipe size. The eye shall be welded closed. Where eye bolts are used in conjunction with harness rods, an appropriate size washer shall be utilized with a nut on each end of the harness rod. Eye bolts shall be of the same material and coating as the harness rods.

3-3.03. Thrust Collars: Collars shall be constructed as shown on the Drawings.

3-3.04. Concrete Blocking: Provide concrete blocking for all bends, tees, valves, and other points where thrust may develop, except where other exclusive means of thrust restraint are specifically shown on the Drawings.

Concrete shall be as specified in Section 03300, Cast-in-Place Concrete.
Form and pour concrete blocking at fittings as shown on the Drawings and as directed by the Engineer. Pour blocking against undisturbed earth. Increase dimensions when required by over excavation.

3-4. INSPECTION AND TESTING. All sections of the water main shall be hydrostatically pressure tested in accordance with AWWA C600 and these Specifications. A section of main will be considered ready for testing after completion of all thrust restraint and backfilling.

Water used for flushing and testing mains and other construction purposes will be made available to the Contractor as specified in Section 01040.

Each segment of water main between main valves shall be tested individually.

3-4.01. Test Preparation: For water mains less than 24-inches in diameter, flush sections thoroughly at flow velocities, greater than 2.5 feet per second, adequate to remove debris from pipe and valve seats. For water mains 24-inches in diameter and larger, the main shall be carefully swept clean, and mopped if directed by the Engineer. Partially open valves to allow the water to flush the valve seat.

Partially operate valves and hydrants to clean out seats.

Provide temporary blocking, bulkheads, flanges and plugs as necessary, to assure all new pipe, valves and appurtenances will be pressure tested.

Before applying test pressure, air shall be completely expelled from the pipeline and all appurtenances. Insert corporation cocks at high points to expel air as main is filled with water as necessary to supplement automatic air valves. Corporation stops shall be constructed with a meter box as shown on the Drawings.
Fill pipeline slowly with water. Provide a suitable pump with an accurate water meter to pump the line to the specified pressure.

The differential pressure across a valve or hydrant shall equal the maximum possible, but not exceed the rated working pressure. Where necessary, provide temporary backpressure to meet the differential pressure restrictions.
Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure.

3-4.02. Test Pressure: Test the pipeline at 250 psi measured at the lowest point for at least two hours. Maintain the test pressure within 5 psi of the specified test pressure for the test duration. Should the pressure drop more than 5 psi at any time during the test period, the pressure shall be restored to the specified test pressure. Provide an accurate pressure gauge with graduation not greater than 5 psi.

3-4.03. Testing Allowance: Testing allowance shall be defined as the sum of the maximum quantity of makeup water that must be added into the pipeline

Undergoing hydrostatic pressure testing, or any valved section, in order to maintain pressure within 5 psi of the specified test pressure for the test duration plus water required to return line to test pressure at the end of the test. Leakage shall be the total cumulative amount measured on a water meter.

The Owner assumes no responsibility for leakage occurring through existing valves.
Test Results: No installed pipe shall be accepted if the quantity of makeup water exceeds the limits determined by the following formula:

$$L = \frac{SD\,(P)^{1/2}}{148{,}000}$$

Where:
L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

As determined under Section 5 of ANSI/AWWA C600.

If the water main section being tested contains lengths of various pipe diameters, the allowable leakage shall be the sum of the computed leakage for each diameter. The leakage test shall be repeated until the test section is accepted. All visible leaks shall be repaired regardless of leakage test results.

After a pipeline section has been accepted, relieve test pressure. Record type, size and location of all outlets on record drawings.

At the conclusion of the work, the contractor shall thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stone, pieces of wood or other material which may have entered the pipeline during the construction period.
The Contractor shall be responsible for legal disposal of all water used for flushing and testing.

3-5. ABANDONING/KILLING EXISTING WATER MAINS AND VALVES

3-5.01. General: Abandon in place all existing water main segments and valves indicated on the Drawings to be abandoned or killed. Abandon existing water mains and valves after the new water main has been placed in service and all water main services have been transferred over to the new main.

The Contractor shall be responsible for uncovering and verifying the size and material of the existing main to be abandoned and cut and plugged.
3-5.02. Cutting and Plugging Main: Disconnect existing main by sawing or cutting and removing a segment of existing pipe where cutting and capping or plugging is shown on the Drawings or as directed by the Engineer.

Provide a watertight pipe cap or plug and concrete blocking for restraint to seal off existing mains indicated to remain in service.

Seal ends of existing mains to be abandoned with a pipe cap or plug or a masonry plug and pour a minimum of 6-inches of concrete on all sides around the end of the pipe.

3-5.03. Valves: Pavement shall be saw cut and removed from around valve box. The direction of the pavement cuts shall be parallel and perpendicular to the direction of the traffic. Size of saw cut shall be 18-inches x 18-inches (maximum).

Remove all valve covers, valve boxes and extension stems from valves on mains to be abandoned/killed. Valves shall remain in place. Deliver all valve covers, valve boxes and extension stems to the Owner's storage yard.

Backfill excavations with suitable material and compact. Install 6-inch graded aggregate base and repave area as required and as directed by the Engineer.

End of Section

Section 02832

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1-1. SCOPE. This section covers chain link fencing and gates. Fencing shall be provided in the alignment indicated on the Drawings and for the following locations:

As shown in drawings

1-2. SUBMITTALS. Complete detail drawings and specifications for the fence, gates, and accessories shall be submitted in accordance with the Submittals Procedures section.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-4. MANUFACTURERS. Manufacturers, subject to compliance with requirements, should be provided from one of the following:

1. Galvanized Steel Fencing and Fabric:
   a. Allied Tube and Conduit Corp.
   b. American Fence Corp.
   c. Anchor Fence, Inc.

2. Aluminum Fencing and Fabric:
   a. Chain Line Fence Company of Pennsylvania
   b. Security Fabricators, Inc.
   c. Boundary Fence & Railing Systems, Inc.

3. Bared Tape:
   a. American Fence Corp.
   b. Man Barrier Corp.
   c. Boundary Fence & Railing Systems, Inc.

PART 2 - PRODUCTS

2-1. FENCE TYPES. Fencing shall conform to the details indicated on the Drawings and unless otherwise specified shall be of the following general types.

Location	Fabric	Height
As shown in drawings	Steel	8 feet

Fence posts shall be directly driven into the earth, supported by concrete cast into drilled holes, set into sleeves set in concrete structures or cast into concrete structures as detailed on the Drawings.

2-2. MATERIALS.

2-2.01. Steel Fencing. All steel or malleable iron parts and accessories shall be hot-dip galvanized, PVC coated or aluminum coated after fabrication.

1. Fabric: No. 9 gauge (0.148" t 0.005") size steel wires, 2" mesh, with top selvages knuckled for fabric 60" high and under, and both top and bottom selvages twisted and barbed for fabric over 60" high:
   a. Furnish one-piece fabric widths for fencing up to 12' high.

2. Fabric Finish: Galvanized, ASTM A 392, Class II, with not less than 2.0 oz. zinc per sq. ft. of surface.

3. Fabric Finish: Aluminized, ASTM A 491, Class II, with not less than 0.40 oz. aluminum per sq. ft. of surface.

4. Fabric Finish: Galvanized, ASTM A 392, Class I, with not less than 1.2 oz. zinc per sq. ft. of surface.

5. Fabric Finish: Minimum 7-mil polyvinyl chloride (PVC) plastic resin finish over galvanized steel wire. Color as selected by Architect from manufacturer's standard color selection:
   a. Comply with ASTM F 668, Class 2.
   b. Comply with ASTM F 668, Class 2, except provide fabric with diameter (gage) of core wire equivalent to fabric diameter specified when measured prior to application of non-metallic coating.
   c. Comply with ASTM F 668, Class 1.

2-2.02. Framing and Accessories.

Steel Framework, General: Galvanized steel, ASTM A 120 or A 123, with not Less than 1.8 oz. Zinc per sq. ft. of surface.

   a. Fittings and Accessories: Galvanized, ASTM A 153, with zinc weights per Table I.

b. Steel Framework Finish: Provide framework, fittings and accessories in accordance with manufacturer's standard thermally bonded polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 10 mils (0.010") thick. Color to match chain link fabric.

Aluminum Framework, General: ASTM B 221, Alloy 6063, mill finished aluminum.

a. Fittings and Accessories: Mill finished aluminum or galvanized steel, to suit manufacturer's standards.

End, Corner and Pull Posts: Minimum sized and weights as follows:

a. Up to 6' fabric height, 2.375" OD steel pipe, 3.65 lbs per linear ft., or 3.5" x 3.5" roll-formed sections, 4.85 lbs per linear ft.
b. Over 6' fabric height, 2.875" OD steel pipe, 5.79 lbs per linear ft., or 3.5" x 3.5" roll-formed sections, 4.85 lbs per linear ft.
c. Either 2.875" OD aluminum pipe 2.0 lbs. per linear ft. or 2.50" square tubing, 2.9 lbs per linear ft.

Line Posts: Space 10' o.c. maximum, unless otherwise indicated, of following minimum sized and weights.

a. Up to 6' fabric height, 1.90" OD steel pipe, 2.70 lbs per linear ft. or 1.875" x 1.625" C-sections, 2.28 lbs per linear ft.
b. 6' to 8' fabric height, 2.375" OD steel pipe, 3.65 lbs per linear ft. or 2.25" x 1.875" H-sections, 2.64 lbs linear ft.
c. Over 8' fabric height, 2.875" OD steel pipe, 5.79 lbs per linear ft. or 2.25" x 1.875" H-sections, 3.26 lbs per linear ft.
d. Up to 8' fabric height, either 2.375" OD aluminum pipe, 1.26 lbs per linear ft. or 2.25" x 1.875" H-section, 1.25 lbs per linear ft.
e. Over 8' fabric height, 2.875" OD aluminum pipe, 2.0 lbs per linear ft.

Gate Posts: Furnish posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:

Steel Fencing:

Leaf Width	Gate Post	lbs/ linear ft.
Up to 6'	3.5"x3.5" roll-formed section	4.85
	or 2.875" OD pipe	5.79
Over 6' to 13'	4.000" OD pipe	9.11
Over 13' to 18'	6.625" OD pipe	18.79
Over 18'	8.625" OD pipe	28.55

Aluminum Fencing

Leaf Width	Gate Post	lbs/linear ft.
Up to 6'	2.875" OD	2.004
Over 6' to 13'	4.000" OD	3.151

Over 13’ to 18’	6.625” OD	6.564
Over 18’	8.625” OD	9.878

Top Rail: Manufacturer’s longest lengths, with expansion type couplings, approximately 6” long, for each joint. Provide means for attaching top rail securely to each gate corner, pull and end post.

a. Steel fencing: 1.66” OD pipe, 2.27 lbs. Per ft. or 1.625” x 1.25” roll-formed sections, 1.35 lbs. Per ft.
b. Aluminum fencing: 1.66” OD pipe, .86 lbs per ft.

Tension Wire: 7-gage, coated coil spring wire, metal and finish to match fabric. Locate at bottom and top of fabric.

Wire Ties: 11 gauge galvanized steel of 11-gauge aluminum wire, to match fabric core material.

Post Brace Assembly: Manufacturer’s standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line post with 0.375” diameter rod and adjustable tightener.

Post Tops: Provide weathertight closure cap with loop to receive tension wire or top rail; one cap for each post.

Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross-section of 3/16” x 3/4”. Provide one stretcher with bar for each gate and end post, and 2 for each corner and pull post, except where fabric is integrally woven into post.

Stretcher Bar Bands: Space not over 15” o.c., to secure stretcher bars to end, corner, pull, and gateposts.

Barbed Wire Supporting Arms: Manufacturer’s standard barbed wire supporting arms, metal and finish to match fence framework, with provision for anchorage to posts and attaching 3 rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap and must be capable of withstanding 250 lbs. downward pull at outermost end. Provide following type: Single 45-degree arm; for 3 strands barbed wire, one for each post.

Barbed Wire: 2 strand 12-1/2 gauge. Wire with 14 gauge. 4-point barbs spaced not more than 5” o.c.; metal and finish to match fabric.

2-2.03. Gates.

Fabrication: Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding or with special fittings and rivets for rigid

connections, providing security against removal or breakage connections. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware and accessories. Space frame member's maximum of 8' apart unless otherwise indicated.

a. Provide same fabric as for fence, unless otherwise indicated. Install fabric with stretcher bars at vertical edges and at top and bottom edges. Attach stretcher bars to gate frame at not more than 15' o.c.
b. Install diagonal cross bracing consisting of 3/8" diameter adjustable length truss rods on gates to ensure frame rigidity without sag or twist.
c. Where barbed wire is indicated above gates, extend end members of gate frames 1"-0" above to member and prepare to receive 3 strands of wire. Provide necessary clips for securing wire to extensions.

Swing Gates: Fabricate perimeter frames of minimum 1.90" OD pipe.

Gate Hardware: Provide hardware and accessories for each gate, galvanized per ASTM A 153, and in accordance with the following:

a. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180 degree gate opening. Provide 1-1/2 pair of hinges for each leaf over 6' nominal height.
b. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
c. Keeper: Provide keeper for vehicle gates, which automatically engages gate leaf and holds it in open position until manually released.
d. Double Gates: Provide gate stops for double gates, consisting of mushroom type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Include locking device and padlock eyes as integral part of latch, permitting both gate leaves to be locked with single padlock.

Concrete: Provide concrete consisting of Portland cement, ASTM C 150, aggregates ASTM C 33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 3000 psi using at least 4 sacks of cement per cu. Yd., 1" maximum size aggregate, maximum 3" slump, and 2% to 4% entrained air.

2-2.03. Aluminum Alloy Fencing. Not Used

2-2.03. Padlocks. A padlock shall be provided for each gate latch and shall be Schlage "45-102-26D", with two keys. All padlocks shall be keyed alike. Contractor shall provide padlocks compatible with the existing lock system of the Owner and all padlocks shall be operable with the Owner's master key.

PART 3 - EXECUTION

3-1. INSTALLATION.

3-1.01. Do not begin installation and erection before final grading is completed, unless otherwise permitted.

3-1.02. Excavation: Drill or hand excavate (using post hole digger) holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than 4 times largest cross-section of post.

2. Unless otherwise indicated, excavate hole depths approximately 3” lower than post bottom, with bottom of posts set not less than 36” below finish grade surface.

3. Setting Posts: Center and align posts in holes 3” above bottom of excavation.

4. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.

5. Unless otherwise indicated, extend concrete footings 2” above grade and trowel to a crown to shed water.

3-1.03. Top Rails: Run rail continuously through post caps, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

3-1.04. Center Rails: Provide center rails where indicated. Install in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.

3-1.05. Brace Assemblies: Install braces as posts are plumb when diagonal rod is under proper tension.

3-1.06. Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with not less than 6 ga. galvanized wire. Fasten fabric to tension wire using 11 ga. Galvanized steel hog rings spaced 24” o.c.

3-1.07. Fabric: Leave approximately 2” between finish grade and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.

3-1.08. Stretcher Bars: Thread through or clamp to fabric 4” o.c., and secure to posts with metal bands spaced 15” o.c.

3-1.09. Barbed Wire: Pull wire taut and install securely to extension arms and secure to end post or terminal arms in accordance with manufacturer's instructions.

3-1.10. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3-1.11. Tie Wires: Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing. Tie fabric to line posts, with wire ties spaced 12" o.c. Tie fabric to rails and braces, with wire ties spaced 24" o.c. Tie fabric to tension wires, with hog rings spaced 24"o.c.

3-1.12. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

End of Section

SECTION 02834

SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes single- and multiple-depth segmental retaining walls with and without soil reinforcement.

B. Related Requirements:

1. Section 02200 “Excavation and Fill for Structures”.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each color and texture of concrete unit specified. Submit sections of units not less than 3 inches (75 mm) square.

C. Delegated-Design Submittal: For segmental retaining walls.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each type of segmental retaining wall unit and soil reinforcement from manufacturer.

1. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
2. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

C. Product Test Reports: For each type of segmental retaining wall unit and soil reinforcement, for tests performed by a qualified testing agency.

1. Include test data for freeze-thaw durability of segmental retaining wall units.
2. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
3. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

D. Research/Evaluation Reports: For segmental retaining wall units and soil reinforcement, from ICC-ES.

E. Preconstruction test reports.

F. Source quality-control reports.

G. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall as indicated on Drawings.

a. Include typical soil reinforcement.
b. Include typical base and cap or finished top construction.
c. Include backfill to typical finished grades at both sides of wall.
d. Include typical end construction at one end of mockup.
e. Include 36-inch (900-mm) return at one end of mockup, with typical corner construction.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.

2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of another manufacturer are proposed, engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.

B. Delegated Design: Engage a qualified professional engineer who is licensed in the State of Georgia to design segmental retaining walls.

C. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

D. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls." .

1. Gravity loads due to equivalent fluid soil pressures resulting from grades and sloped backfill indicated the drawings. Equivalent fluid soil pressures are indicated on the structural notes sheet. Heights and back fill elevations are indicated on the respective Civil Drawings.
2. Superimposed loads (surcharge) due to slopping soil and traffic where applicable.

2.2 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch (1.6 mm) from specified dimension.

1. List of Manufacturers:
    a. Allan Block Corporation
    b. Tensar Earth Technologies, Inc
    c. Versa-Lok Retaining Wall Systems
2. Provide units that comply with requirements in ASTM C 1372 for freeze-thaw durability as determined by testing.
3. Provide units that interlock with courses above and below by means of integral lugs, lips, or tongues and grooves; pins; clips; splines; or hollow cores filled with drainage fill.

B. Color: As indicated by manufacturer's designations and as approved by Owner.

C. Shape and Texture: Provide units with smooth, flat exposed face.

1. Face Dimensions: 8 inches (200 mm) high by 16 inches (400 mm) long.

D. Shape and Texture: Provide units matching basic shape, dimensions, and face texture of basis-of-design product.

E. Shape and Texture: Provide units of any basic shape and dimensions that produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with machine-split textured or smooth.

F. Batter: Provide units that offset from course below to provide at least 1:16 batter.

G. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.

H. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

2.3 INSTALLATION MATERIALS

A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

C. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

D. Leveling Base: Comply with requirements in Section 02200 “Excavation and Fill for Structures” for base course.

1. Leveling Course: Lean concrete with a compressive strength of not more than 500 psi (3.4 MPa).

E. Drainage Fill: Comply with requirements in Section 02200 “Excavation and Fill for Structures” for drainage course.

F. Reinforced-Soil Fill: Comply with requirements in Section 02200 “Excavation and Fill for Structures” for satisfactory soils.

G. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; complying with the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 (4.75-mm) sieve, zero to 60 percent passing No. 40 (0.425-mm) sieve, zero to 35 percent passing No. 200 (0.075-mm) sieve, and with fine fraction having a plasticity index of less than 20.

H. Nonreinforced-Soil Fill: Comply with requirements in Section 02200 “Excavation and Fill for Structures” for satisfactory soils.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

J. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).

K. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:

1. List of Manufacturers:
   a. Strata Systems, Inc

b. Tensar Earth Technologies, Inc
c. Versa-Lok Retaining Wall Systems

2. Product Type: Knitted or woven geogrid made from polyester yarns with a protective coating.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect each roll of soil reinforcement for minimum average roll values for geosynthetic index property tests, including the following:

1. Weight.
2. Grab or single-rib strength.
3. Aperture opening.
4. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in running bond.
2. Form corners and ends by using special units.

B. Do not use units with chips, cracks, or other defects that are visible at a distance of 20 feet (6 m) where such defects are exposed in the completed Work.

C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

1. Leveling Course: Place unreinforced lean concrete over leveling base 1 to 2 inches (25 to 50 mm) thick. Compact and screed concrete to a smooth, level surface.

D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
4. For units with pins, install pins and align units.
5. For units with clips, install clips and align units.

F. Cap Units: Place cap units and secure with cap adhesive and pins as indicated on the Drawings.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 02200 “Excavation and Fill for Structures” with NCMA's "Segmental Retaining Wall Installation Guide," and with segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches (1200 mm) of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
b. In areas where fill height exceeds 15 feet (4.5 m), compact reinforced-soil fill that will be more than 15 feet (4.5 m) below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D 698.
c. In areas where fill height exceeds 30 feet (9 m), compact reinforced-soil fill that will be more than 30 feet (9 m) below finished grade to not less than 100 percent maximum dry unit weight according to ASTM D 698.

3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place drainage geotextile against back of wall, and place layer of drainage fill at least 12 inches (300 mm) wide behind drainage geotextile to within 12 inches (300 mm) of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Place a layer of drainage fill at least 12 inches (300 mm) wide behind wall to within 12 inches (300 mm) of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.

G. Place impervious fill over top edge of drainage fill layer.

H. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.

I. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches (200 mm) into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least 6 inches (150 mm) of fill over reinforcement before compacting with tracked vehicles or 4 inches (100 mm) before compacting with rubber-tired vehicles.

5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet (32 mm in 3 m), 3 inches (75 mm) maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet (32 mm in 3 m).

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet (32 mm in 3 m).

D. Maximum Gap between Units: 1/8 inch (3 mm).

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 02200 “Excavation and Fill for Structures” for field quality control.

1. In each compacted backfill layer, perform at least one field in-place compaction test for each 150 feet (45 m) or less of segmental retaining wall length.
2. In each compacted backfill layer, perform at least one field in-place compaction test for each 24 inches (600 mm) of fill depth and each 50 feet (15 m) or less of segmental retaining wall length.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
2. Segmental retaining walls that do not match approved Samples.
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION

SECTION 02900

TREES, PLANTS AND GROUND COVERS

PART 1 - GENERAL

1-1. DESCRIPTION. Provide trees, plants, and ground covers as shown and specified.

1-1.01. The work includes:
1. Soil preparation.
2. Trees, plants, and ground covers.
3. Planting mixes.
4. Mulch and planting accessories.
5. Existing tree care.
6. Filling around trees to remain.
7. Maintenance.

1-2. QUALITY ASSURANCE. Comply with Division 2 requirements.

Plant names indicated, comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade.

Provide stock true to botanical name and legibly tagged.

Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position.

All plants shall be nursery grown under climatic conditions similar to those in the locality of the project for a minimum of 2 years.

Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional cost, and providing that the larger plants will not be cut back to size indicated. Provide plants indicated by two measurements so that only a maximum of 25% are of the minimum size indicated and 75% are of the maximum size indicated.

Provide "specimen" plants with a special height, shape, or character of growth. Tag specimen trees or shrubs at the source of supply. The Engineer will inspect specimen selections at the source of supply for suitability and adaptability to selected location. When specimen plants cannot be purchased locally, provide sufficient photographs of the proposed specimen plants for approval.

Plants may be inspected and approved at the place of growth, for compliance with

specification requirements for quality, size, and variety.

Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.

Provide and pay for material testing. Testing agency shall be acceptable to the Engineer. Provide the following data: (Test representative material samples proposed for use)

Topsoil:

a. pH factor.
b. Mechanical analysis.
c. Percentage of organic content.

Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

Peat Moss:

a. Loss of weight by ignition.
b. Moisture absorption capacity.

1-3. SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Mulch samples.
2. Planting accessories samples.
3. Certification for topsoil source and pH value; peat moss and plant fertilizer.
4. Material test reports.

Upon plant material acceptance, submit written maintenance instructions recommending procedures for maintenance of plant materials.

Plant material record drawings:
Legibly mark drawings to record actual construction.
Indicate horizontal and vertical locations, referenced to permanent surface improvements.

Identify field changes of dimension and detail and changes made by Change Order.

1-4. DELIVERY, STORAGE, AND HANDLING. Deliver fertilizer materials in original, unopened, and undamaged containers showing weight, analysis, and name of manufacturer. Store in manner to prevent wetting and deterioration.
Take all precautions customary in good trade practice in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Spray deciduous

plants in foliage with an approved "Anti-Desiccant" immediately after digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury. Inspection certificates required by law shall accompany each shipment invoice or order to stock and on arrival, the certificate shall be filed with the Engineer.

Protect all plants from drying out. If plants cannot be planted immediately upon delivery, properly protect them with soil, wet peat moss, or in a manner acceptable to the Engineer. Water heeled-in plantings daily. No plant shall be bound with rope or wire in a manner that could damage or break the branches.

Cover plants transported on open vehicles with a protective covering to prevent wind burn.

Provide dry, loose topsoil for planting bed mixes. Frozen or muddy topsoil is not acceptable.

1-5. PROJECT CONDITIONS. Work notification: Notify Engineer at least 7 working days prior to installation of plant material.

Protect existing utilities, paving, and other facilities from damage caused by landscaping operations.

A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plans shall govern.

The irrigation system may be installed prior to planting. Locate, protect, and maintain the irrigation system during planting operations. Repair irrigation system components, damaged during planting operations, at Contractor's expense.

1-6. WARRANTY. Warrant plant material to remain alive and be in healthy, vigorous condition for a period of 1 year after completion and acceptance of each contract item as listed in bid package.

Inspection of plants will be made by the Engineer at completion of planting. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Engineer, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes due to the Contractor's negligence. The cost of such replacement(s) is at Contractor's expense. Warrant all replacement plants for 1 year after installation.

Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting area; acts of vandalism or negligence on the part of the Owner.

Remove and immediately replace all plants, as determined by the Engineer to be unsatisfactory during the initial planting installation.

PART 2 - PRODUCTS

2-1. MATERIALS

2-1.01. Plants: Provide plants typical of their species or variety; with normal, densely-developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sunscald injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. All plants shall have a fully developed form without voids and open spaces. Plants held in storage will be rejected if they show signs of growth during storage.

Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock". Cracked or mushroomed balls are not acceptable.

2-1.02. Container-grown stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.

No plants shall be loose in the container.

Container stock shall not be pot bound.

Provide tree species that mature at heights over 25 feet with a single main trunk. Trees that have the main trunk forming a "Y" shape are not acceptable.

Plants planted in rows shall be matched in form.

Plants larger than those specified in the plant list may be used when acceptable to the Engineer.

If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.

The height of the trees, measured from the crown of the roots to the top of the top branch, shall not be less than the minimum size designated in the plant list.
No pruning wounds shall be present with a diameter of more than 1" and such wounds must show vigorous bark on all edges.

Evergreen trees shall be branched to the ground.

Shrubs and small plants shall meet the requirements for spread and height indicated in the plant list.

1. The measurements for height shall be taken from the ground level to the height of the top of the plant and not the longest branch.
2. Single stemmed or thin plants will not be accepted.
3. Side branches shall be generous, well-twigged, and the plant as a whole well-bushed to the ground.
4. Plants shall be in a moist, vigorous condition, free from dead wood, bruises, or other root or branch injuries.

2-2. ACCESSORIES

2-2.01. Topsoil for Planting Beds and Tree Pits: Fertile, friable, natural topsoil of loamy character, without admixture of subsoil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sands, stones, plants, roots, sticks, and other foreign materials, with acidity range of between pH 6.0 and 6.8.

Topsoil that has been stripped and stockpiled on site shall be the topsoil to be utilized on this project. Provide additional topsoil if necessary.

Provide topsoil free of substances harmful to the plants which will be grown in the soil. Provide 12-inches of topsoil in all plant beds and tree pits.

Planting mixture shall be composed of four (4) parts topsoil, two (2) parts peat moss, one (1) part sharp sand and one (1) part well rotted manure, mixed together thoroughly, and worked into existing soil.

2-2.02. Peat Moss: Brown to black in color, weed and seed free granulated raw peat or baled peat, containing not more than 9% mineral on a dry basis.

Provide ASTM D2607 sphagnum peat moss with a pH below 6.0 for ericaceous plants.

2-3. FERTILIZER:

2-3.01. Plant Fertilizer Type "A": Commercial type approved by the Engineer, containing 5% nitrogen, 10% phosphoric acid, and 5% potash by weight. 1/4 of nitrogen in the form of nitrates, 1/4 in form of ammonia salt, and 1/2 in form of organic nitrogen.
2-3.02. Plant Fertilizer Type "B": Approved acid-base fertilizer.

2-3.03. Anti-Desiccant: Protective film emulsion providing a protective film over plant surfaces; permeable to permit transpiration. Mixed and applied in accordance with manufacturer's instructions.

Premium grade shredded pine bark 3/4" to 1-1/2" diameter. Furnish in - 3 cu. ft. bags or bulk.

2-3.04. Water: Free of substances harmful to plant growth. Hoses or other methods of transportation furnished by Contractor.

2-3.05. Stakes for Staking: Hardwood, 2" x 2" x 8'-0" long.

2-3.06. Stakes for Guying: Hardwood, 2" x 2" x 36" long.

2-3.07. Guying/Staking/Wire: No. 10 or 12, gage galvanized wire.

For large trees (4" caliper and greater) use turnbuckles and heavier gage wire as indicated below

Stakes for Staking: Hardwood, 4"x 4"x 8'-0" long.

Guying/Staking/Wire: No. 6 or 8 gage galvanized wire.

2-3.08. Turnbuckles: Galvanized steel of size and gage required to provide tensile strength equal to that of the wire. Turnbuckle openings shall be at least 3".

2-3.09. Staking and Guying Hose: Two ply, reinforced garden hose not less than 1/2" inside diameter.

2-3.10. Tree Wrap: Standard waterproofed tree wrapping paper, 2-1/2" wide, made of 2 layers of crepe kraft paper weighing not less than 30 lbs. per ream, cemented together with asphalt. Tree wrap shall be removed at 12 months after installation of plant material.

2-3.11. Twine: Two-ply jute material.

2-3.12. Soil Separator: Rot resistant polypropylene filter fabric, water permeable, and unaffected by freezing and thawing.

2-3.13. Drainage Tile: ASTM F405 corrugated polyethylene drainage tubing, perforated.

2-3.14. Drainage Fill: AASHTO M43 #6(3/8" to 3/4") clean uniformly graded stone or gravel.

PART 3 - EXECUTION

3-1. INSPECTION. Examine proposed planting areas and conditions of installation. Do not start planting work until unsatisfactory conditions are corrected.

3-2. CARE OF TREES TO REMAIN

3-2.01. Minor fills of 6" or less: Fill with topsoil; hand grade to required finish grade elevation.

3-2.02. Moderate fills of 12" or less: Place layer of 3/4" to 1-1/2" stone or gravel on grade. Provide aggregate depth 1/2 of fill height, minimum of 3". Cover drainage fill with polypropylene filter fabric or 1" thickness straw choke. Fill remaining depth with loose topsoil; hand grade to required finish grade elevations.

3-2.03. Deep fills over 12": Place layer of 3/4" to 1-1/2" stone or gravel on grade. Extend drainage fill to within 2" of required finish grade. Cover drainage fill with polypropylene filter fabric or 1" thickness straw choke. Fill remaining depth with loose topsoil; hand grade to required finish grade elevation. Provide tile drainage system and vents as indicated.

3-2.04. Deep fills over 18": Place 4" depth of 1" to 2" stone or gravel fill on grade, extending three (3) feet beyond the outer branch drip line around tree branch perimeter. Cover drainage fill with polypropylene filter fabric or 1" thickness straw choke. Place 1" to 2" stone or gravel fill around tree trunk, extending to within 2" of required finish grade elevation. Fill remaining depth with loose topsoil; hand grade to required finish grade elevation. Do not place earth fill in contact with tree trunk, maintain 18" diameter of drainage fill exposed at finish grade.

3-3. PREPARATION

3-3.01. Time of planting:

3-3.02. Evergreen material: Plant evergreen materials between September 1 and November 1 or in spring before new growth begins. If project-I requirements require planting at other times, plants shall be sprayed with anti-desiccant prior to planting operations.

3-3.03. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in-leaf, they shall be sprayed with an anti-desiccant prior to planting operation.

Planting times other than those indicated shall be acceptable to the Engineer.

Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

Locate plants as indicated or as approved in the field after staking by the Contractor. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operations until alternate plant locations have been selected.

Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds. Provide shrub pits at least 12" greater than the diameter of the root system and 24" greater for trees. Depth of pit shall accommodate the root system. Provide undisturbed tamped down topsoil to hold root ball at nursery grade as shown on the drawings. Remove excavated materials from the site.

Provide pre-mixed planting mixture for use around the balls and roots of the plants consisting of planting topsoil and 1/2 lb. plant fertilizer Type "A" for each cu. yd. of mixture.

Provide pre-mixed ground cover bed planting mixture consisting of 3 parts planting topsoil to 1 part peat moss and 1/2 lb. plant fertilizer Type "A" per cu. yd. Provide beds a minimum of 12" deep. If slopes are greater than 4 to 1 increase depth to 18".

Provide pre-mixed planting mixture for use around the balls and roots of ericaceous plants consisting of 2 part planting topsoil to 1 part sphagnum peat moss and 1/2 lb. plant fertilizer Type "B" per cu. yd. of mixture.

3-4. INSTALLATION. Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material 2"-3" above the finish grade. No filling will be permitted around trunks or stems. Backfill the pit with planting mixture. Do not use frozen or muddy mixtures for backfilling. Form a ring of soil around the edge of each planting pit to retain water.

After balled and burlapped plants are set, muddle planting soil mixture around bases of balls and fill all voids.

Remove all burlap, ropes, and wires from the tops of balls of trees and remove entirely from all other plant material.

Space ground cover plants in accordance with indicated dimensions. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within 12" of the trunks of trees and shrubs within planting bed and to within 6" of edge of bed.

NOTE: Provide drainage tiles if Contractor encounters standing water in planting pits or conditions warrant.

3-4.01. Drain tile: Install drainage tile with perforations down and closed joints, firmly bedded in minimum 4" layer of granular fill material. Provide full bearing for each pipe section. Provide continuous slope in the direction of flow.

Provide collars and couplings for all in-line joints and elbows for all corners and changes in direction.

Provide unperforated run out pipe. Extend drainage tile to out fall indicated and make connection.

Obtain required inspections and perform testing before backfilling. Remove obstructions, replace damaged components, and retest system as required. Provide a satisfactory free flowing drainage tile system.

Place drainage fill over drain piping after satisfactory testing and acceptance. Compact drainage fill layers not exceeding 6" in loose depth. Exercise care to avoid damage or displacement of installed piping.

Completely cover drain lines to width of at least 6" each side of pipe and above top of pipe to within 18" of finish grade.

Provide soil separator over drainage fill prior to topsoil fill. Overlap a minimum of 6".

Install topsoil fill over compacted drainage fill. Compact topsoil fill in layers not exceeding 6" in loose depth. Extend topsoil fill to indicated finish grade elevations. Slope topsoil fill away from building.

3-4.02. Mulching: Mulch tree and shrub planting pits and shrub beds with required mulching material 3" deep immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.

Mulch ground cover beds with mulch 2" deep immediately after planting.

3-4.03. Wrapping, guying, staking: Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.

Wrap trunks of all trees spirally from bottom to top with specified tree wrap and secure in place.

Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.

Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom. Wrapping and twine to be removed 12 months after installation of plant material.

3-4.04. Staking/Guying: Stake/guy all trees immediately after lawn seeding or sodding operations and prior to acceptance. When high winds or other conditions which may

effect tree survival or appearance occur, the Engineer may require immediate staking/guying.

Stake deciduous trees under 3" caliper. Stake evergreen trees under 8'-0" tall.

Guy deciduous trees over 3" caliper. Guy evergreen trees over 8'-0" tall.

All work shall be acceptable to the Engineer.

3-4.05. Pruning: Prune branches of deciduous stock, after planting, to balance the loss of roots and preserve the natural character appropriate to the particular plant requirements. In general, remove 1/4 to 1/3 of the leaf bearing buds, proportion shall in all cases be acceptable to the Engineer. Remove or cut back broken, damaged, and unsymmetrical growth of new wood.

3-4.06. Multiple leader plants: Preserve the leader which will best promote the symmetry of the plant. Cut branches flush with the trunk or main branch, at a point beyond a lateral shoot or bud at a distance of not less than 1/2 the diameter of the supporting branch. Make cut on an angle.

Prune evergreens only to remove broken or damaged branches.

3-4.07. Care of existing trees: Selectively prune existing trees in designated areas, under Engineer's direction. Remove sucker shoots, dead, rubbing, and damaged branching.
Fertilize designated existing trees with 2 to 3 lbs. of Type "A" plant fertilizer per inch of trunk diameter, for trees less than 6" diameter and 3 to 5 lbs. for trees greater than 6" diameter.

Fertilize in early spring before growth begins or in late October.

Fertilize at 2' to 3' on center in a triangular pattern to a depth of 18" within the dripline.

Injection or drilling fertilization methods, when used, shall be acceptable subject to Engineer's approval.
Water existing trees every 2 weeks until acceptance. Water thoroughly with a fine mist sprinkler head soaker hose or hose at a low flow rate over the entire drip line area as required to allow water to penetrate to a depth of 12" to 18".

3-4.08. Tree relocation: transplant trees designated for relocation to locations shown on the drawings. Prune, dig, ball and burlap, move and plant in accordance with specified tree planting requirements.

3-5. MAINTENANCE. Maintain plantings until completion and acceptance of the entire project.

Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.

Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.

Tighten and repair guy wires and stakes as required.

Remove tree wrapping and twine 12 months after installation of plant material.

Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.

Water trees, plants, and ground cover beds within the first 24 hours of initial planting, and not less than twice per week until final acceptance.

3-6. ACCEPTANCE. Inspection to determine acceptance of planted areas will be made by the Engineer, upon Contractor's request. Provide notification at least 10 working days before requested inspection date.

Planted areas will be accepted provided all requirements, including maintenance, have been complied with and plant materials are alive and in a healthy, vigorous condition.

Upon acceptance, the Owner will assume plant maintenance.

3-7. CLEANING. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soils, debris, and equipment. Repair damage resulting from planting operations.

End of Section

SECTION 02933

SEEDING AND SODDING

PART 1 GENERAL

1-1. SCOPE: The work covered by this Section consists of furnishing all labor, equipment and material required to place topsoil, seed, commercial fertilizer, agricultural limestone and mulch material, including seedbed preparation, harrowing, compacting and other placement operations on graded earthen areas as described herein and/or shown on the Drawings.

Seeding operations shall be conducted on all newly graded earthen areas not covered by structures, pavement or sidewalks; all cleared or grubbed areas which are to remain as finish grade surfaces; and on all existing turf areas which are disturbed by construction operations and which are to remain as finish grade surfaces. Areas disturbed by borrow activities shall also be seeded according to these Specifications.

The Work shall also include temporary seeding operations to stabilize earthen surfaces during construction or inclement weather and to minimize stream siltation and erosion. Temporary seeding shall be performed at the times and locations as directed by the Engineer.

1-2. SUBMITTALS: Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following information shall be submitted:

1. Prior to seeding operations, labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the Contractor of any responsibility or liability for furnishing seed meeting the requirements of this Section.

2. Prior to topsoil operations, the Contractor shall obtain representative samples and furnish soil test certificates including textural, pH, and organic ignition analysis from the State University Agricultural Extension Services or other certified testing laboratory.

PART 2 PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS: Wood cellulose fiber mulch shall be manufactured by Weyerhauser Company or Conway Corporation.

2-2. MATERIALS AND CONSTRUCTION

2-2.01. Topsoil: Utilizing designated stockpiles or borrow areas on site, the Contractor shall place a minimum of 6-inches of topsoil over all graded earthen areas and over any other areas to be seeded. Sources of topsoil shall be approved by the Engineer prior to disturbance.

Topsoil shall be a friable loam containing a large amount of humus and shall be original surface soil of good, rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2-inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips or other undesirable material harmful or unnecessary to plant growth.

Topsoil shall be reasonably free from perennial weeds and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life.

Topsoil shall be natural topsoil without admixture of subsoil material, and shall be classifiable as loam, silt loam, clay loam, sandy loam or a combination thereof. The pH shall range from 5.5 to 7.0. Topsoil shall contain not less than 5 percent nor more than 20 percent, by weight, or organic matter as determined by loss on ignition of oven dried samples to 65 Degrees C.

2-2.02. Seed: Seed shall be hulled common Bermuda (Cynodon Dactylon) guaranteed by the dealer to be 98% minimum purity and 90% minimum germination and certified free of giant strain Bermuda.

Seed shall be delivered in new bags or bags that are sound and labeled in accordance with the U.S. Department of Agriculture Federal Seed Act.

All seed shall be from the last crop available at time of purchase and shall not be moldy, wet or otherwise damaged in transit or storage.

Seed shall bear the growers analysis testing to 98 percent for purity and 90 percent for germination. At the discretion of the Engineer, samples of seed may be taken for check against the grower's analysis.

Species, rate of seeding, fertilization and other requirements are shown in Table 02933-1 at the end of this Section.

2-2.03. Fertilizer and Liming Materials: Fertilizer and liming materials shall comply with applicable state, local and federal laws concerned with their production and use.

Commercial fertilizer shall be a ready mixed material and shall be equivalent to the grade or grades specified in Table 02933-1. Container bags shall have the name and address of the manufacturer, the brand name, net weight and chemical composition.

Agricultural limestone shall be a pulverized limestone having a calcium carbonate content of not less than 85 percent by weight.

Fertilizer shall be a complete fertilizer, the content of which shall meet the following minimum requirements: 10% nitrogen, 10% phosphoric acid, 10% potash, available materials. Fertilizer shall be uniform in composition, dry and free flowing, and shall be delivered to the site in original unopened containers bearing the manufacturer's statement of guarantee.

Ammonium Nitrate shall be a standard brand and shall be delivered to the site in original unopened containers. It shall contain not less than 33-1/3% Nitrogen.

2-2.04. Mulch Material: All mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.

Mulch shall be composed of wood cellulose fiber, straw or stalks, as specified herein.

Mulch shall be suitable for spreading with standard mulch blowing equipment.

Straw mulch shall be partially decomposed stalks of wheat, rye, oats or other approved grain crops.

Stalks shall be the partially decomposed, shredded residue of corn, cane, sorghum or other approved standing field crops.

2-2.05. Mulch Binder: Mulch on slopes exceeding 3 to 1 ratio shall be held in place by the use of an approved mulch binder. The mulch binder shall be non-toxic to plant life and shall be acceptable to the Engineer.

Emulsified asphalt binder shall be Grade SS-1, ASTM D977. Cutback asphalt binder shall be Grade RC 70 or RC 250.

2-2.06. Inoculants for Legumes: All leguminous seed shall be inoculated prior to seeding with a standard culture of nitrogen fixing bacteria that is adapted to the particular seed involved.

2-2.07. Water: Water shall be clean, clear water free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the Contractor.

2-2.08. Sod: Sod shall be living, growing sod of Bermuda hybrids "Tifway 419" or Tifgreen 328". This includes sod which is dormant during the cold or dry season and capable of renewing growth after the dormant period. All sod shall be obtained from approved sources. The presence of weeds or other noxious growth or any other foreign material which may be detrimental to the proposed planting will be cause of rejection. At least 85% of the plants in the sod shall be composed of the designated variety of Bermuda grass.

The Engineer shall be notified of sources before it is harvested. Approval of such sources shall not be construed as an acceptance of the material. The sod will be subject to inspection while it is being planted and any material which has been permitted to dry out excessively or exposed to extreme heat, or which is not viable, will be rejected.

In the harvesting of the sod, grass more than 3-inches tall shall be mowed to a height of 3-inches, raked and removed before sod cutting begins. The sod shall be cut into square or rectangular sections which may vary in length, but which shall be of uniform width and thickness, and shall have at least ½-inch of soil adhering firmly to the roots.

Care shall be exercised at all times to retain the soil on the roots of the sod during the process of cutting, transporting and planting. Sod shall be transplanted within 24 hours from the time it is harvested. All sod stored shall be kept moist, shall be protected from exposure to the air and sun and from freezing, and shall not be stored for more than 10 days. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected.

PART 3 - EXECUTION

3-1. SECURING AND PLACING TOPSOIL: Topsoil shall be secured from areas from which topsoil has not been previously removed, either by erosion or mechanical methods. Topsoil shall not be removed to a depth in excess of the depth approved by the Engineer.

The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage and other characteristics as to offer assurance that, when removed the product will be homogeneous in nature and will conform to the requirements of these Specifications.

All areas from which topsoil is to be secured, shall be cleaned of all sticks, boards, stones, lime, cement, ashes, cinders, slag, concrete, bitumen or its residue and any other refuse which will hinder or prevent growth.

In securing topsoil from a designated pit, or elsewhere, should strata or seams of material occur which do not come under the requirements for topsoil, such material shall be removed from the topsoil or if required by the Engineer, the pit shall be abandoned.

Before placing or depositing topsoil upon any areas, all improvement within the area shall be completed, unless otherwise approved by the Engineer.
The areas in which topsoil is to be placed or incorporated shall be prepared before securing topsoil for use.

3-2. SEEDBED PREPARATION: Before liming, fertilizing and seeding, the topsoil surfaces shall be trimmed and worked to true line from unsightly variation, bumps,

ridges and depressions and all detrimental material, roots and stones larger than 3-inches in any dimension shall be removed from the soil.

Not earlier than 24 hours before the seed is to be sown, the soil surface to be seeded shall be thoroughly cultivated to a depth of not less than 2-inches with a weighted disc, tiller, pulvimixer or other equipment, until the surface is smooth and in a condition acceptable to the Engineer.

If the prepared surface becomes eroded as a result of rain or for any other reason, or becomes crusted before the seed is sown, the surface shall again be cultivated for seeding.

Ground preparation operations shall be performed only when the ground is in a tillable and workable condition, as determined by the Engineer.

3-3. FERTILIZATION AND LIMING: Following seedbed preparation, fertilizer shall be applied to all areas to be seeded so as to achieve the application rates shown in Table 02933-1 at the end of this Section.

Fertilizer shall be spread evenly over the seedbed and shall be lightly harrowed, raked, or otherwise incorporated into the soil for a depth of 1/2-inch.

Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment. The seed shall not remain in water containing fertilizer for more than 30 minutes when a hydraulic seeder is used.

Agricultural limestone shall be thoroughly mixed into the soil according to the rates in Table 02933-1. The specified rate of application of limestone may be reduced by the Engineer if pH tests indicate this to be desirable. It is the responsibility of the Contractor to obtain such tests and submit the results to the Engineer for adjustment in rates.

It is the responsibility of the Contractor to make one application of a maintenance fertilizer according to the recommendations listed in Table 02933-1.

On the approved grade, spread 20 lbs. per 1,000 sq. ft. of 10-10-10 fertilizer into top 3-inches, hand rake and smooth. The surface shall be brought to finish grade requirements, allowance being made for settlement. Finish grades shall be smooth and free from hollows or other inequalities.
Three weeks after construction of lawns add ammonium nitrate at the rate of 5 lbs. per 1000 sq. ft. of lawn area, and thoroughly water in.

3-4. SEEDING: Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. No seed shall be sown during high winds, nor until the surface is suitable for working and is in a proper condition. Seeding shall be performed during the dates shown in Table 02933-1 unless otherwise approved by the Engineer. Seed mixtures may be sown together provided they are kept in a thoroughly

mixed condition during the seeding operation.

Seed shall be uniformly sown by any approved mechanical method suitable for the slope and size of the areas to be seeded, preferably with a broadcast type seeder, windmill hand seeder or approved mechanical power drawn seed drills. Hydro-seeding and hydro-mulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder for seedings at the proper rate before seeding operations are started and to maintain their adjustment during seeding. Seed in hoppers shall be agitated to prevent segregation of the various seeds in a seeding mixture.

Immediately after sowing, the seeds shall be covered and compacted to a depth of 1/8 to 3/8-inch by a cultipacker or suitable roller.

Leguminous seeds shall be inoculated prior to seeding with an approved and compatible nitrogen-fixing inoculant in accordance with the manufacturer's mixing instructions.

Italian rye grass (Lolium Multiflorum) shall be evenly seeded with a mechanical spreader at the rate of 5 lbs. per 1000 sq. ft. of area, lightly rake, suitably compact and thoroughly water. Before planting the permanent lawn, the rye shall be thoroughly scarified in a manner to incorporate it into the top three inches of the ground.

The planting of bermuda grass shall be done only within the season extending from April 15 to August 1.

3-5. MULCHING: All seeded areas shall be uniformly mulched in a continuous blanket immediately after seeding. The mulch shall be applied so as to permit some sunlight to penetrate and the air to circulate and at the same time shade the ground, reduce erosion and conserve soil moisture. Approximately 25 percent of the ground shall be visible through the mulch blanket.

One of the following mulches shall be spread evenly over the seeded areas at the following application rates:

Wood Cellulose Fiber	1,400 pounds/acre
Straw	4,000 pounds/acre
Stalks	4,000 pounds/acre

These rates may be adjusted at the discretion of the Engineer at no additional cost to the Owner, depending on the texture and condition of the mulch material and the characteristics of the seeded area.

The Contractor shall cover structures, poles, fence and appurtenances if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.

Mulch and binder shall be applied by suitable blowing equipment at closely controlled application rates in a manner acceptable to the Engineer.

3-6. WATERING: The Contractor shall be responsible for maintaining the proper moisture content of the soil to insure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain adequate water content in the soil.

Watering shall be accomplished by hoses, tank truck or sprinklers in such a way to prevent erosion, excessive runoff and overwatered spots.

3-7. MAINTENANCE: Upon completion of seeding operations, the Contractor shall clear the area of all equipment, debris and excess material and the premises shall be left in a neat and orderly condition.

The Contractor shall maintain all seeded areas without additional payment until final acceptance of the work by the Owner, and any regrading, refertilizing, reliming, reseeding or remulching shall be done at the Contractor's own expense. Seeding work shall be repeated on defective areas until a satisfactory uniform stand is accomplished. Damage resulting from erosion, gulleys, washouts or other causes shall be repaired by filling with topsoil, compacting and repeating the seeding work at the Contractor's expense.

Contractor's guarantee of one (1) year shall also cover a fully rooted stand of grass.

End of Section

TABLE 02933-1
SEEDING REQUIREMENTS

Area	Sowing Season	Species	Seed	Rates per 1,000 Square Feet		
				Fertilizer	Limestone	Maintenance**
Flat to rolling terrain with slopes less than 3:1	3/1 to 4/15	Rebel II Turf-Type Tall Fescue	6-8 lbs.	30 lbs. 6-12-12	200 lbs.	10 lbs. 10-10-10
	9/1 to 11/15	Rebel II Turf-Type Tall Fescue	6-8 lbs.	30 lbs. 6-12-12	200 lbs.	15 lbs. 10-10-10
Embankments with slopes greater than 3:1	3/1 to 6/1	Crownvetch* Kentucky 31 Fescue Weeping Lovegrass	1 lb. 2 lbs. 1/4 lb.	30 lbs. 6-12-12	200 lbs.	10 lbs. 0-20-20
	8/1 to 11/1	Crownvetch* Kentucky 31 Fescue Annual Ryegrass	1 lb. 2 lb. 2 lb.	30 lbs. 6-12-12	200 lbs.	10 lbs. 0-20-20

* Requires inoculation
** Maintenance fertilizer shall be applied in early spring following initial establishment of cover

Section 03100

CONCRETE FORMING

PART 1 - GENERAL

1-1. SCOPE. This section covers formwork for cast-in-place concrete.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-2. GENERAL. All forms shall be accurately and properly placed so cast-in-place concrete may be placed as indicated on the Drawings and as specified. The forms shall produce a smooth concrete finish free from offsets or irregularities. The use of stay in place forms is expressly prohibited.

1-3. SUBMITTALS. All submittals of catalog data sheets, manufacturers' certificates of compliance and other data shall be in accordance with the Submittals Procedures section.

A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

Form Coating
Form Ties

PART 2 – PRODUCTS

2-1. MATERIALS.

Forms

Prefabricated	Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", or Universal "Uni-form".
Plywood	Product Standard PS1, waterproof, resin-bonded, exterior type Douglas fir, face adjacent to concrete Grade B or better.
Fiberboard	ANSI/AHA A135.4, Class 1, tempered, water-resistant, concrete form hardboard.

Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Chamfer Strips	Clear white pine, surface against concrete planed.
Form Coating	Nonstaining and nontoxic after 30 days. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

2-2. FORMS. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the Drawings. Formwork shall comply with ANSI A10.9 and OSHA Construction Standards, Part 1926, Subpart Q, Concrete, Concrete Forms, and Shoring. In addition, forms shall conform to ACI 347 and the following additional requirements.

Forms for surfaces which will be exposed to view after construction is completed shall be constructed of prefabricated plywood panels, job-built of plywood, or lined with plywood or fiberboard. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and concave or convex areas, within the tolerances specified herein.

Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the interior of manholes, basins, and reservoirs. Other types of forming materials, such as steel or unlined wood, may be used where plywood or lined forms are not required and may be used as backing for form linings.

All vertical concrete surfaces above footings shall be formed.

Flat segmented forms not more than 24 inches [600 mm] wide may be used for forming curved surfaces 25 feet [7600 mm] in diameter or larger.

2-2.01. Design. Formwork shall be in accordance with ACI 347 and as follows:

a. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that permissible working stresses are not exceeded.

b. Beams and slabs supported by concrete columns shall be formed so that the column forms may be removed without disturbing the supports for the beams or slabs.

c. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms shall be brought to a true line and grade, or a wooden guide strip shall be placed at the proper location on the forms so that the concrete surface can be finished with a screed or template to the specified elevation, slope, or contour. At horizontal construction joints in walls, the forms on one side shall not extend more than 2 feet [600 mm] above the joint.

d. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection.

e. Design, erect, support, brace and maintain formwork so that it shall safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system or in-place construction that has attained adequate strength for this purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.

f. Design forms and false work to include make full allowance for all of live loads, dead loads, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

g. Forms shall conform to shape, lines and dimensions of members indicated and shall be sufficiently rigid and tight to prevent leakage of mortar. Forms shall be properly braced or tied together so as to maintain position and shape. Construct forms so that they can be removed readily without hammering or prying against the concrete. Forms shall be carefully made and accurately placed to obtain correct shape and lines.

h. Joints shall be butted tight. Arrangements of panels shall be orderly and symmetrical, and use of small pieces shall be avoided. Forms shall be

chamfered 1-inch for external corners of concrete, including tops of walls, which will be exposed to view in the finished work.

i. Provide adequate formwork in its entirety. Forms shall safely support loads they will sustain and shall maintain their dimensional and surface correctness to produce members required by the Drawings. Form ties shall be spaced close enough to avoid bulges and variations in the required cross-sectional dimensions shown on the Drawings for the members being cast.

j. Box out for chases, recesses or other openings required in the completed work.

k. Install all the items (sleeves, inserts, hangers, anchors, etc.) to be supported by the formwork as required by the work.

l. Install pipe sleeves, wall pipes and wall sleeves, as shown or specified, for all piping penetrating walls and slabs. The use of block-outs in walls is prohibited.

m. Provide a sufficient number of cleanout doors at the base of walls and columns to facilitate cleaning and the application of grout to the base of walls.

n. The use of reinforcing steel, partially embedded in concrete, as toe pins or form spacers is prohibited.

o. Forms for Exposed Concrete:

1. Do not use metal cover plates for patching holes or defects in forms.

2. Provide sharp, clean corners at intersecting planes, without visible edges of offsets. Back joints with extra beams or girts to maintain true, square intersections.

3. Use extra beams walers and bracing to prevent bowing of forms between beams and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.

4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.

5. Form molding shapes, recessed and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

6. Chamfer exposed corners and edges.

2-2.02. Form Ties. Form ties shall have removable end and permanently embedded body, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie, and the permanently embedded portion shall be at least 1 inch [25 mm] back from the concrete face. Form ties for liquid-containing walls shall be provided with water stop washers located on the permanently embedded portions of the ties at the approximate center of the wall. Permanently embedded portions of form ties without threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete. Through-wall tapered removable ties will not be acceptable. The type of form ties used shall be acceptable to Engineer.

Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.

2-2.03. Edges and Corners. Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Equipment bases shall have formed beveled salient edges for all vertical and horizontal corners, unless specifically indicated otherwise on the Drawings. Unless otherwise noted, bevels shall be 3/4 inch [19 mm] wide.

2-2.04. Cleaning and Tightening. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Re-tighten forms immediately after concrete placement as required to- eliminate mortar leaks.

2-3. ARCHITECTURAL CONCRETE. Architectural concrete shall conform to the applicable requirements of Section 6 of ACI 301 and to the additional requirements specified herein. Architectural concrete shall be free from holes, sand streaks, mortar leakage, offsets, irregularities, and other defects. Particular care shall be taken in forming, placing, and finishing architectural concrete.

2-3.01. Forms. Forms for architectural concrete shall conform to the requirements specified for all concrete forms and shall be fabricated from plastic overlay plywood or fiberglass reinforced plastic. All joints shall be watertight. Forms shall be reinforced, braced, and supported as necessary to obtain the required straightness tolerance.

PART 3 – EXECUTION

3-1. PLACEMENT. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer.

Before concrete is placed, forms shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow from within the formwork before concrete is placed.

3-2. TOLERANCES. Tolerances for cast-in-place concrete work shall be as stipulated in ACI 117, unless otherwise indicated. Maximum acceptable deflection is 1/8" in 5'-0" on all flat surfaces (ACI 347 Class A Finish).

3-3. FORM COATING. All concrete forms shall have form release agent applied to them before placement of concrete.

Coat form contact surfaces with a non-staining no petroleum formcoating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces, which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

Volatile organic compound emissions of form releasing agents shall not exceed 2.09 pounds per gallon or that as acceptable in the State, County, or District of their intended use, whichever is more stringent.

Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

Form releasing agents must not impair subsequent treatment of concrete surfaces that depend upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

3-4. INSTALLATION OF EMBEDDED ITEMS. Set and build into the formwork, anchorage devices and other embedded items, shown specified or required by other Section. Refer to paragraph 1.01 herein for the requirements of coordination. Use necessary setting drawings, diagrams, instructions and directions.

All embeds should be supported, plumbed and carefully taped or covered to prohibit the infiltration of concrete during the pour.

Coat any aluminum or reactive metal inserts, with non-reactive coating to isolate the metal surfaces.

Set edge forms or bulkheads and intermediate screed strips for slabs and sidewalks to obtain required elevations and contours in the finished slab surface. Provide and secure units to support screeds.

The screeds may not be tack welded to the rebar embeds, or structural steel.

3-5. FIELD QUALITY CONTROL. Before concrete placement, the Engineer shall inspect all formwork. No concrete shall be poured without Engineer's approval.

Before concrete placement, Contractor shall check the formwork, including lines, ties, tie cone, and form coatings. He shall make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

During concrete placement Contractor shall check formwork and related supports to ensure that forms are not displaced and that completed Work shall be within specified tolerances.

If Contractor finds that forms are unsatisfactory in any way, either before or during placing of concrete, placement of concrete shall be postponed or stopped until the defects have been corrected, and reviewed by the Engineer.

3-6. FORM REMOVAL. Forms shall not be removed from structures until the concrete in the structures has sufficient strength to support the weight of the structure and any superimposed load, including loads from construction operations. Contractor shall be responsible for limiting any applied loadings. There shall be no evidence of damage to concrete and no excessive deflection or distortion of members due either to the removal of forms or to loss of support.

Do not use pinch bars or similar tools to pry against concrete surfaces.

Do not remove forms until concrete has aged as follows:

1. Elevated slabs and beams: 7 days minimum.

2. Grade beams, columns, walls, construction and expansion joint bulkheads and other vertical surfaces: 24 hours minimum.

Supporting formwork (soffit material only) for horizontal members shall not be removed until the concrete has attained at least 75 percent of the specified 28 day compressive strength as determined by cylinders made and cured in the field. Shoring systems for horizontal members shall not be removed until the concrete has attained the full specified 28 day compressive strength, but may be temporarily removed for the purpose of removing the soffit material as permitted above. Shoring shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon. Determine concrete strength for form removal in conformance with ACI 301.

Reshore elevated concrete elements immediately upon form removal. Shoring shall remain in place until the concrete has attained the specified 28 day design strength.

Maintain shoring of elevated concrete elements which support subsequent construction when the subsequent construction loads exceed the design live load of the elements

When forms are removed before the specified curing is completed, measures shall be taken to immediately continue curing and to provide adequate thermal protection for the concrete.

3-7. REUSE OF FORMS. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

Plywood surfaced forms must have smooth clean faces for re-use, and may not have excessive knots or tie hole plugs. They may not be used more than (3) times without an Engineer's inspection and approval.

Metal surfaced forms must have a smooth even surface without plate patches.

3-7. PAN-FORMED JOISTS. Not Used.

End of Section

Section 03200

CONCRETE REINFORCING

PART 1 – GENERAL

1-1. SCOPE. This section covers reinforcement for cast-in-place and precast concrete.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. All submittals of drawings, manufacturers' certificates of compliance, certification of reinforcement, reinforcement bar lists, placement drawings, test data, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

Bar lists and drawings for the fabrication and placing of reinforcement shall be submitted for review and shall have sufficient plans, elevations, and sections to adequately detail and label all reinforcement. The bar lists and drawings shall also include a reference to the structure in which the reinforcement will be installed and to the Drawing showing the reinforcement.

In addition, the following specific information shall be provided:

Shop Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, Chapters 1 thru 8. Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrications and placement of concrete reinforcement unless otherwise noted. Splices shall be kept to a minimum. Show construction joints.

Copies of manufacturer's specifications and installation instructions for all materials and reinforcement accessories.

5 copies of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

1-2.02. Manufacturer's Certificate of Compliance. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

Mechanical connections

1-3. QUALITY ASSURANCE. Contractor shall examine the substrate and the conditions under which concrete reinforcement is to be placed, and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

Reference standards shall comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. Concrete Reinforcing Steel Institute, "Manual of Standard Practice", includes ASTM standards referred to herein.
2. ACI 318, "Building Code Requirements for Reinforced Concrete".
3. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
4. ACI 350, Environmental Engineering concrete structures.
5. Concrete Reinforcing Steel Institute, Placing Reinforcing Bars.
6. AWS D.1, Structural Welding Code.

Minimum Concrete Cover for Reinforcement: Comply with ACI 350, except as shown on Drawings:

Splices other than lap splices shall not be used except where permitted in writing by the Engineer.

Reinforcement which arrives on the jobsite which is not tagged as specified in Paragraph 1-4 shall be rejected by the Engineer and removed at the Contractor's expense.

1-4. DELIVERY. STORAGE AND HANDLING. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, length, and other information corresponding to markings shown on placement diagrams.

Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground.

PART 2 – PRODUCTS

2-1. MATERIALS.

Bars, Except Weldable	ASTM A615, Grade 60, deformed.
Bars, Weldable	ASTM A706 or A615, Grade 60, deformed, with maximum carbon

	equivalent of 0.55%.
Column Spirals	ASTM A82 A1064, cold drawn wire.
Welded Wire Fabric	ASTM A185 or A497 A1064.
Bar Supports	CRSI Class 1, plastic protected; or Class 2, stainless steel protected. Shall be located in accordance with CRSI MSP-1 and placed in accordance with CRSI PRB. Precast concrete block supports shall be provided for reinforcing in concrete cast against grade.
Mechanical Connections	Classified Type 2 per ACI 318. Dayton/Richmond "Dowel Bar Splicer" or "Coupler Splice" System, Bar-Lock “Coupler Systems” or Barsplice Products or Lenton by Erico.

2-2. REINFORCEMENT. Reinforcement shall be accurately formed and shall be free from loose rust, scale, concrete splatter, and contaminants which reduce bond. Unless otherwise indicated on the Drawings or specified herein, the details of fabrication shall conform to ACI SP-66 and ACI 318.

2-2.01. Splices. Splices shall conform to the details indicated on the Drawings. Splices at locations other than those indicated on the Drawings shall be submitted to Engineer for review and concurrence.

2-2.02. Mechanical Connections. Mechanical connections shall be used only as indicated on the Drawings. Connections in adjacent bars shall be spaced at least 30 inches [760 mm] apart.

2-2.03. Welding. Except where indicated on the Drawings, welding or tack welding of reinforcement is not permitted. Preheating and welding shall conform to AWS D1.4. Reinforcement which has been welded improperly or without Engineer's concurrence shall be removed and replaced.

2-3. FABRICATION. Fabricate reinforcing bars and dowelling to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice" and ACI minimums. In case of fabricating errors, do not re-bend, retemper, heat, deform or straighten reinforcement.

Unacceptable Materials: Reinforcement with any of the defects listed below will not be permitted in the Work:

1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
2. Bends or kinks not shown on approved Shop Drawings.
3. Bars with reduced cross-section due to excessive rusting or other cause.
4. Surface contamination that would affect the bond i.e. grease, dirt, paint, rust etc.
5. Heat deformed or torched bars.

PART 3 – EXECUTION

3-1. INSTALLATION. Reinforcement shall be accurately positioned on supports, spacers, hangers, or other reinforcement, and shall be secured in place with wire ties or suitable clips. Tolerances shall be as stipulated in ACI 117 and ACI 318 unless otherwise indicated. Comply with the applicable recommendations of specified codes and standards, and CRSI "Placing Reinforcing Bars" requirements for details and methods of reinforcement placement and supports.

3-1.01. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete. All surfaces encrusted with dried concrete from previous placements shall be cleaned and the entire installation shall be acceptable to Engineer.

3-1.02. Position, support, and secure reinforcement and dowelling against displacement during formwork construction or concrete placement and grouting operations. Locate and support reinforcing by metal chairs, blocks, runners, bolsters, spacers and hangers, as required. No wood blocks allowed for rebar support.

Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 350. Arrange, space, and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.

Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

Reinforcement at the bottom of concrete slabs and mats shall not be supported from contact with subgrade by the use of metal supports or bent reinforcement.

Where reinforcement in beams is placed in two or more layers, the bars in the upper layer shall be placed directly above the bars in the lower layer.

Reinforcement for beams or slabs which are supported by concrete columns shall not be installed until after the concrete for the column has been placed.

3-1.03. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with 16 gauge wire and tie.

3-1.04. Provide sufficient numbers of supports of strength required to carry reinforcement without sagging. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

3-1.05. 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.

3-1.06. Existing concrete which is shown to remain but is removed in error or must be removed to install new Work, is to be reinforced to the extent as required and approved by the Engineer. This work will be performed with no additional compensation to the Contractor.

3-1.07. Do not straighten or rebend reinforcing.

3-1.08. Reinforcement Around Openings: Place an equivalent area of steel around the pipe or openings and extend on each side sufficiently to develop bond in each bar. See the Details on the Drawings for bar extension length each side of openings. Where welded wire fabric is used, provide extra reinforcing using fabric or deformed bars.

3-1.09. Welded Reinforcement: Welding shall not be permitted unless the Contractor submits detailed shop drawings, qualifications, and radiographic nondestructive testing procedures for review by the Engineer. Reinforcing bars to be welded shall conform to ASTM A706; other bars shall not be welded. The Contractor shall obtain the Engineer's approval prior to proceeding. The basis for the Contractor submittals shall be The Structural Welding Code, Reinforcing Steel, AWS D1.4-79, published by the American Welding Society and the applicable portions of ACI 318, current edition. The Contractor shall test 10 percent of all welds using radiographic, nondestructive testing procedures referenced in this code.

3-2. INSPECTION OF REINFORCEMENT. After the rebar, appliance, anchors and embedments have been installed and checked, the Contractor shall review all aspects of the pending concrete pour and initial those items on its pour card. Contractor shall notify the Engineer no less than 24 hours prior to the pour, so that the Engineer may check the area and pour. No concrete shall be placed until this is complete.

Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by the Engineer. All concrete placed in violation of this provision will be rejected. Rejected concrete shall be removed and replaced at no cost to the City.

3-3. PLACING CONCRETE. Concrete shall be placed and compacted in wall or column forms before any reinforcement supported by such walls or columns is placed in the form system.

3-4. DUCT BANKS. All reinforcement and other magnetic materials installed in duct banks shall be installed parallel to the individual ducts, unless they enclose all the ducts of the duct bank.

End of Section

Section 03250

CONCRETE JOINTS AND ACCESSORIES

PART 1 – GENERAL

1-1. SCOPE. This section covers concrete accessories including construction, contraction and expansion joints for cast-in-place concrete.

Dovetail anchor slots shall be as specified in the Masonry section.

1-2. GENERAL. All accessories shall be accurately placed and all joints shall be accurately and properly constructed so cast-in-place concrete can be placed as specified and as indicated on the Drawings.

1-3. DRAWINGS AND DATA. All submittals of manufacturers' certificates of compliance, test data, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. MATERIALS.

Metal Waterstops

Carbon steel	Uncoated, 12 gage minimum thickness, size as indicated on the Drawings.
Stainless steel (at structures for ozonated water or carbon slurry)	ASTM A480/A666, Type 304 or 316, 14 gage minimum thickness, size as indicated on the Drawings.
PVC Waterstops	Extruded, virgin, elastomeric, polyvinyl chloride (PVC), white (no pigment), ribbed, 3/8 inch min thick. Reclaimed material will not be acceptable. Provide hog rings or grommets spaced at 12 inches on center entire length.

At construction joints in concrete sections less than 12 inches in thickness	6 inches wide; Greenstreak “679” or Vinylex “R638”
At construction joints in concrete sections 12 inches or more in thickness	9 inches wide; Greenstreak “646” or Vinylex “R938”
At control joints in concrete sections less than 12 inches in thickness	6 inches wide with an "O" bulb closed center section; Greenstreak "732" or Vinylex "RB638H".
At control joints in concrete sections 12 inches or more in thickness	9 inches wide with an "O" bulb closed center section; Greenstreak "735" or Vinylex "RB938H".
Expandable Waterstops, permitted only at locations indicated on Drawings	Hydrophilic; bentonite free, chemically modified rubber. Adeka "Ultra Seal MC-2010MN" or Greenstreak "Hydrotite CJ-1020-2K". Adhesive as recommended by the manufacturer.
Sealant for expandable waterstop	Adeka “Ultra Seal P-201” or Greenstreak “Leakmaster”.
Expansion joint materials	
Filler	Preformed sponge rubber, ASTM D1752, Type I.
Filler adhesive	As recommended by manufacturer.
Sealant	As specified in the caulking section.
Polyethylene film	NBS Product Standard PS17 or ASTM D4397, 6 mils or thicker.

Vapor retarder and seam tape	Polyolefin membrane, 15 mil min, ASTM E1745, Class A, with maximum water vapor permeance of 0.02 perms. Stego Industries “Stego Wrap 15 Mil”, Raven Industries “Vaporblock 15”, Reef Industries “Griffolyn 15 Mil Green”, W.R. Meadows “Perminator 15”, Insulation Solutions “Viper VaporCheck II”. Manufacturer recommended seam tape and pipe boots.
Bearing pads	Preformed cotton duck reinforced pads, at least 1/4 inch thick; JVI "Capralon" or Voss Engineering "Sorbtex".
Epoxy bonding agent	As specified in Concrete Placing, Finishing and Curing section.
Wedge inserts	Malleable iron, with galvanized askew-head bolts, nuts, and washers; Hohmann and Barnard "HW", Richmond "Peerless", or Weston "WC50".

PART 3 - EXECUTION

3-1. CONSTRUCTION JOINTS. Construction joints shall be made at locations indicated on the Drawings or where specified. Construction joints shall not be made at other locations without the concurrence of Engineer.

3-1.01. Location. Construction joints shall be located as follows:

a. In Columns and Walls. At the underside of beams, girders, haunches, drop panels, and column capitals, and at floor levels. All haunches, drop panels, and column capitals shall be considered part of the supported floor or roof and shall be placed monolithically therewith. Column bases will not be required to be monolithic with the floor beneath. Walls shall be divided into sections not to exceed 60 feet, except at corners which shall be as indicated on the Drawings.

b. In Beams and Girders. Within the middle third of the span, unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset by twice the width of the beam. Provisions for the transfer of shear and other forces through the construction joint shall be acceptable to Engineer. Members shall be divided into pour sections not greater than 60 feet in length.

c. In Suspended Slabs. At or near the center of the span in flat slab or T-beam construction. No joint will be permitted between a slab and a concrete beam or girder unless specifically required by the Drawings. Suspended floor systems shall be divided by construction joints into approximately square sections not to exceed 60 feet [18 m] in their longest dimension.

d. In Bottom Slab. Each bottom slab shall be divided into approximately square sections not to exceed 60 feet [18 m] in their longest dimension.

Construction joints in beams, girders, joists, and slabs shall be perpendicular to the planes of their surfaces.

3-1.02. Watertight Joints. Construction joints in the following locations shall be watertight and shall be provided with continuous waterstops, unless noted otherwise on the Drawings:

a. Walls and bottom slabs of dry pits or rooms where below finished grade and in contact with backfill or subgrade material on the opposite side.

b. Slabs or perimeter walls below the liquid surface elevation of liquid-containing structures.

c. Structural divider walls where it is possible for one side or “cell” to be out of service and for the other side to be liquid-containing.

d. Walls, floors, and top slabs of filters and clear water reservoirs.

e. Other locations where specifically indicated on the Drawings.

3-2. EXPANSION AND CONTRACTION JOINTS. Expansion joint filler shall be firmly bonded to the previously poured joint face with a suitable adhesive, and the new concrete shall be poured directly against the joint filler. Accessible edges of each expansion and contraction joint shall be sealed as specified in the caulking section.

3-3. WATERSTOPS.

3-3.01 Placement. Each waterstop shall be continuous throughout the length of the joint in which it is installed. Waterstops shall be clean, free from coatings, and shall be maintained in proper position until surrounding concrete has been deposited and compacted. Waterstop embedment shall be equal on both sides of the joint.

Expandable waterstops shall be located as nearly as possible to the center of the joint and shall not be installed when air temperature falls outside the manufacturer's recommended range.

3-3.02. Storage and Handling. Expansion joint filler and elastomeric (PVC or TPV) waterstops shall be stored in a cool place protected from direct sunlight.

Metal waterstops shall be handled, transported, delivered, and stored in a manner which will prevent bends, dents, or corrosion.

3-3.03. Splices. Junctions between adjacent sections of metal waterstops shall be lapped 5 inches and securely bolted, screwed, or spot welded together.

Junctions between adjacent sections of elastomeric (PVC or TPV) waterstops shall be spliced in strict conformity with the recommendations of the manufacturer. Directional changes and intersections shall be factory fabricated by the waterstop manufacturer prior to delivery to the Site. Field splices will be acceptable only in straight sections.

Expandable waterstops shall be contact lapped a minimum distance of 8 inches [200 mm]. Voids shall be filled with sealant.

Where an expandable waterstop is used in combination with metal or PVC water stops, the expandable water stop shall be placed in contact and shall overlap a minimum distance of 12 inches. Voids shall be filled with sealant.

3-4. PLACEMENT. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer.

3-5. EMBEDMENTS. Anchor bolts, castings, steel shapes, conduits, sleeves, masonry anchors, and other objects that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.

Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be placed on the concrete side of the form or template. A second nut shall be placed on the other side of the form or template, and the two nuts shall be so adjusted that the bolt will be held rigidly in proper position.

3-6. DUCT BANK JOINTS. Hardened surfaces that are to receive additional concrete shall be prepared by removing all loose particles, scum, and laitance so that the

aggregate is exposed. The hardened surface shall then be thoroughly wetted and a thin coating of neat cement mortar shall be spread over the entire surface just before the fresh concrete is placed. The fresh concrete shall be puddled and spaded to eliminate any honeycomb or lack of mortar near the joint.

3-7. PLACEMENT AGAINST SUBGRADE. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high-pressure water spray.

3-7.01. Polyethylene Film. Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film. Joints in the film shall be lapped at least 4 inches and taped.

3-7.02. Vapor Retarder. Vapor retarder shall be installed at the locations indicated on the Drawings. Installation shall be in accordance with ASTM E1643 and the manufacturer's recommendations. Joints in the retarder shall be sealed with waterproof sealing tape. Care shall be exercised to avoid tearing or puncturing the retarder. Any damage shall be promptly repaired, and the retarder shall be inspected for damage immediately before the concrete is placed.

3-8. BEARING PADS. Wherever a concrete beam is supported by a concrete bracket, a bearing pad shall be placed in the joint between the beam and the bracket.

End of Section

Section 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1-1. SCOPE. This section covers procurement of all cast-in-place concrete, including concrete materials, limiting requirements, mixture design, and performance requirements, and delivery to the Site through discharge at the end of the delivery truck chute.

Work beyond the end of the delivery truck chute is covered in the Concrete Forming, Concrete Joints and Accessories, Concrete Reinforcing, Concrete Placing, Concrete Finishing, and Concrete Curing sections.

Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.

2. Notify other trades in advance of the placing of concrete to provide the other trades with sufficient time for furnishing of items included in their work that must be installed in the concrete.

3. Required City formal pour card with all required signatures.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-2. GENERAL. All cast-in-place concrete shall conform to the limiting requirements of this specification including Table 1.

1-2.01. Concrete Classifications. Concrete classifications shall be defined and used as indicated for the following classes:

Concrete Classifications

Class	Class Description
A.	Structural Concrete

Class Class Description

A1. Concrete for Liquid-Containing Structures. Concrete for liquid-containing environmental structures, liquid-containing tanks, interior suspended slabs in high humidity areas, headwalls, chemical storage or containment areas, below grade structures exposed to groundwater under normal conditions, and all other concrete not otherwise indicated.

A2. Small Aggregate Concrete; Congested Areas. Structural small aggregate concrete shall be used in all areas (including liquid-containing structures) where the clear distance between reinforcement, conduit, or embedded items is less than the largest dimension of coarse aggregate particles in the structural concrete.

A3. Concrete for Non-Liquid-Containing Structures. Concrete for footings, foundations, manholes, catch basins, pan-formed joists, and all other structural concrete other than for liquid-containing structures.

A4. Mortar Puddle. Placed in a lift 2 inches or more deep at the bottom of forms for walls and columns immediately before structural concrete is placed.

A5. Drilled Pier Concrete. Not Used.

B. Exterior Flatwork Concrete. Concrete for exterior slabs on grade, plant pavement, sidewalks, curbs and gutters, and small equipment pads.

C. Architectural Concrete. Not Used.

D. Miscellaneous Concrete

D1. Ductbanks, Pipe Blocking, Concrete Fill, and Pipe Encasement Concrete. Concrete used in ductbanks, pipe blocking, concrete fill and pipe encasements.

D2. Underwater Concrete. Not Used. Unless otherwise permitted by Engineer, concrete shall not be deposited underwater.

D3. Mass Concrete. Not Used.

D4. Pan Stairs Concrete. Not Used.

Class Class Description

D5. Wash Water Trough Concrete. Not Used.

D6. Composite Topping Concrete. Not Used.

D7. Lean Concrete. Not Used.

1-3. SUBMITTALS. All data shall be submitted in accordance with the Submittals Procedures section, unless otherwise specified herein.

The required submittal data for each Class of concrete shall be as indicated in Tables 2A, 2B, and 2C.

1-3.01. Preliminary Review of Materials. Reports covering the source and quality of concrete materials proposed for the work shall be submitted to Engineer for review within 30 days after the preconstruction conference.

A manufacturer's certificate of compliance, which includes copies of independent test results confirming compliance with specified requirements, shall be submitted for the following materials:

Cement.

Admixtures.

Fly Ash.

Slag Cement.

Fibers.

1-3.02. Proposed Mixture Proportions. Data indicating the proposed material quantities in each Class of concrete shall be submitted to Engineer for review within 30 days after the preconstruction conference.

1-3.03. Field Test Record Data. Concrete mixture field test record performance data shall be submitted to Engineer for review and acceptance. Field test record data shall be acceptable only for the Classes of concrete indicated as such in Table 2C.

1-3.04. Laboratory Trial Mixture Test Results. Laboratory trial mixture testing shall not begin until materials and proposed mixture proportions have been reviewed and are acceptable to Engineer. Trial mixture testing shall be

performed for all Classes of concrete where field test record data is not acceptable as a means of qualifying the mixture.

1-4. STORAGE AND HANDLING. Cement, slag cement and fly ash shall be stored in suitable moistureproof enclosures. Cement, slag cement and fly ash which have become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.

PART 2 - PRODUCTS

2-1. LIMITING REQUIREMENTS. Unless otherwise specified, each concrete mixture shall be designed and controlled, within the following limits, to provide a dense, durable concrete suitable for the expected service conditions.

Concrete materials shall be selected and concrete shall be proportioned, batched, mixed, and delivered in a manner that will minimize shrinkage and cracking as specified herein, and in accordance with Chapters 3 and 8 of ACI 224R. Concrete temperatures shall be controlled before and until delivery at the end of the delivery truck chute to minimize cracking. Any rise in concrete temperature caused by environmental conditions that will be conducive to excessive shrinkage shall be controlled.

Mix design shall be proportioned in accordance with ACI 211.1 making maximum use of the coarse aggregate. The proportioning shall be based on the requirements of a well-graded high density plastic workable mix within the slump range and strengths required. The mix shall be based on conventional conveying and shall not be altered for use in pumping. Pumping equipment, if used, shall be of sufficient size and design to pump the mix designed for conventional conveyance.

For each class of concrete, each concrete mixture shall be designed and concrete shall be controlled within the limits in the specification and in Table 1.

2-1.01. Cementitious Material Content Limits. The minimum quantity of Portland cement in the concrete shall be as indicated in Table 1.

The cementitious material content shall not be increased beyond the Table 1 values more than necessary to achieve the required f'_{cr}.

Contractor may substitute fly ash for Portland cement within the percentage ranges indicated in Table 1, on the basis of 1.0 lbs of fly ash added for each lb of Portland cement reduction.

Contractor may substitute slag cement for Portland cement within the percentage ranges indicted in Table 1 on the basis of 1.0 lbs of slag cement added for each lb of Portland cement reduction.

Mixtures using slag cement in combination with fly ash will not be acceptable.

2-1.02. Maximum Water-Cementitious Material Ratio. The maximum water-cementitious material ratio shall be on a cement mass basis, or, if fly ash or slag cement is used, the combined mass of cement plus fly ash or slag cement shall be used to determine the water-cementitious materials ratio. Limiting maximum water-cementitious material ratios are indicated in Table 1.

2-1.03. Aggregates. Aggregates shall comply with ASTM C33 except as specified herein. Fine aggregate shall be clean natural sand. Dune sand, bank run sand, and artificial or manufactured sands are not acceptable. Coarse aggregate shall be crushed rock, washed gravel, or other inert granular material, meeting Class 4S requirements, except that clay and shale particles shall not exceed values indicated in Table 1.

Gradation of coarse aggregate shall conform to maximum nominal size grading requirements of ASTM C33. When a combination of two or more sizes is used, the combined gradation shall meet ASTM C33 requirements.

Aggregates used in concrete shall have a combined aggregate distribution similar to the aggregates used in the concrete trial mixtures. Reports of individual aggregates shall include sieve sizes 1-1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, and No. 50 in accordance with ASTM E11.

Specified sand equivalent for fine aggregate shall be not less than indicated in Table 1 for an average of 3 samples tested in accordance with ASTM D2419.

To comply with the specified concrete shrinkage test requirements, the clay and shale content of the aggregates may need to be reduced by washing the aggregate.

2-1.04. Ratio of Fine to Total Aggregates. The ratio of fine to total aggregates, based on solid volumes (not weights), shall be as follows:

Maximum Nominal Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
3/8 inch	0.45	0.60
1/2 inch	0.40	0.55
3/4 inch	0.35	0.50
1 inch	0.30	0.46
1-1/2 inch	0.25	0.40

2-1.05. Slump. Concrete slump shall be kept as low as possible, consistent with proper handling and thorough consolidation. Prior to the addition of admixtures, slump shall be at least 2 inches and shall not exceed the maximum slump as indicated in Table 1.

When superplasticizer is dispensed at the ready-mix plant, the concrete mixture design shall be based on a maximum slump as indicated in Table 1. When superplasticizer is dispensed at the Site, the slump of the concrete delivered shall not exceed the maximum slump as indicated in Table 1 before superplasticizer is added.

2-1.06. Initial Set. The initial set, as determined by ASTM C403, shall be attained 5-1/2 hours ±1 hour after the water and cementitious materials are added to the aggregates for each concrete mixture. The quantity of retarding admixture shall be adjusted to compensate for variations in temperature and job conditions.

2-1.07. Total Air Content. The total volumetric air content of concrete after placement shall be as indicated in Table 1, and within ±1.5 percent. Air-entraining admixture may be omitted from concrete for interior slabs which are to be steel trowel finished.

2-1.08. Admixtures. Only approved or specified admixtures shall be used.

Unless otherwise acceptable to Engineer, all admixtures shall be from one manufacturer and shall be compatible. Admixtures that are compatible with other admixtures and concrete materials shall not have an adverse affect on the required properties of the concrete nor the specified limiting requirements. The admixture content, batching method, and time of introduction to the mixture shall

comply with these specifications and with the manufacturer's recommendations for minimum shrinkage. The admixture manufacturer shall provide qualified field services as necessary, at no additional cost to Owner.

Admixtures used in the concrete shall be reviewed and accepted by Engineer prior to conducting the laboratory trial mixture testing and the shrinkage testing. No calcium chloride nor admixture containing chloride from sources other than residual impurities in admixture ingredients will be permitted.

Combination of admixtures which cause premature or local dehydration or post-compaction settlement of the concrete surface shall not be used. If any such undesirable characteristics are observed, the use of the mixture shall be discontinued and an alternate mixture design used.

All liquid-containing (Class A1) concrete, and small aggregate (Class A2) concrete that is placed in liquid-containing structures, shall include a high-range water reducing admixture (superplasticizer). Water-reducing admixtures are not required for Classes D1 and D7, but may be included at Contractor’s option. For all other non-liquid-containing concrete, a water-reducing admixture shall be used.

Superplasticizer may be dispensed into the concrete at the plant or on the Site and shall be mixed in accordance with the admixture manufacturer's recommendations. Each superplasticizer dose, when dispensed at the Site, shall be easily verifiable and recorded on the delivery ticket. The superplasticizer for each load shall be accurately proportioned into a separate container prior to dispensing the admixture into the concrete. When truck-mounted dispensers are used, the system shall not be flushed or cleaned with water until after the entire load of concrete has been discharged. When permitted by Engineer, redosing of concrete with superplasticizer shall be done only once. Redosing procedures shall be as recommended by the admixture manufacturer.

A shrinkage reducing admixture may be added to Class A1 concrete. It shall replace an equal volume of mixing water or as otherwise recommended by the admixture manufacturer. The quantity of air entrainment admixture shall be adjusted as required by the admixture manufacturer to keep mixture air content within specified limits.

2-1.09. Fiber Concrete. Not Used.

2-1.10. Strength. In addition to the other limiting requirements to achieve durability and minimize shrinkage, the minimum acceptable compressive strengths of concrete tested at the end of the delivery truck chute, as determined by ASTM C39, shall be as indicated in Table 1.

Adequate test cylinders taken at the point of placement shall also be made to verify that Contractor's concreting procedures comply with applicable industry standard procedures.

2-1.11. Pumped Concrete. Coarse aggregate size for pumped concrete mixtures shall be limited to a nominal maximum of 1-1/2 inch .

2-1.12. Water-Soluble Chloride. Maximum water-soluble chloride ion concentrations in hardened concrete at an age of 28 days shall not exceed the limits expressed as a percentage of mass of cementitious materials as indicated in Table 1.

Test results shall be reported as the percentage of water-soluble chloride ions in the concrete and as a percentage of chloride ion relative to the mass of cementitious materials in the concrete.

Testing of the concrete components for water-soluble chloride ions may be done at the discretion of Contractor. Copies of the reports on such tests shall be furnished to Engineer.

The hardened concrete and each gradation of aggregate used in the concrete shall be tested each time a chloride ion test is conducted on a concrete mixture.

2-1.13. Laboratory Shrinkage Limits. Based on the modified ASTM C157 test procedures as specified herein, the shrinkage limits of concrete shall be the average drying shrinkage of each set of three test specimens cast in the laboratory from a trial mixture as measured at the 21 days drying age, and shall not exceed the values in Table 1.

2-1.14. NSF 61 Compliance. All liquid-containing (Class A1) concrete, small aggregate (Class A2) concrete, and concrete fill (Class D1) that is used in structures that will contain potable water shall comply with NSF/ANSI 61 – Drinking Water System Components – Health Effects.

Where NSF 61 compliance is required all constituent materials shall be NSF 61 compliant including mix water, aggregates, admixtures, and all cementitious materials. Alternately a cylinder test shall be performed for each mixture requiring NSF 61 compliance. Cylinder testing shall follow NSF 61 protocol for cast-in-place cylinder tests and evaluation.

2-1.15. Mineral Colored Concrete. Not Used.

2-1.16. Cold Weather Concrete. Except as modified herein, cold weather concrete shall comply with ACI 306.1. The temperature of concrete at the point of delivery at the end of the delivery truck chute shall be not less than that indicated in ACI 306.1 for corresponding outdoor temperature (in shade) at the time of placement.

When delivered, heated concrete shall be not warmer than 80°F .

2-1.17. Hot Weather Concrete. Except as modified herein, hot weather concrete shall comply with ACI 305.1. At air temperatures of 90°F or above, concrete shall be kept as cool as possible before and during delivery. The temperature of the concrete at the time of delivery at the end of the delivery truck chute shall not exceed the values indicated in Table 1.

2-2. MATERIALS.

Cement	ASTM C 150, Type V or Type II/V. Low Alkali.
Fly Ash	ASTM C618, except that loss on ignition shall not exceed 4 percent. Class F or Class C are acceptable, but Class C shall also be qualified for moderate sulfate resistance as described in ASTM C618, Table 3, Procedure A. The test for sulfate resistance shall be in accordance with ASTM C1012.
Slag Cement	ASTM C989, Grade 100 or Grade 120.
Aggregates, Fine and Coarse	As specified in Limiting Requirements paragraph.
Water	Potable. Water from concrete production operations shall not be used.
Admixtures	
Water Reducing/Normal Set	ASTM C494, Type A, except as otherwise specified herein.

Water Reducing/Retarding	ASTM C494, Type D, except as otherwise specified herein.
Air-Entraining	ASTM C260.
High Range Water Reducing/Normal Set	ASTM C494, Type F, extended slump life type, except as otherwise specified herein.
High Range Water Reducing/Retarding	ASTM C494, Type G, extended slump life type, except as otherwise specified herein.
Shrinkage Reducing Admixture	GCP Applied Technologies (Grace) "Eclipse 4500", Euclid "Eucon SRA", or BASF "MasterLife SRA 035". These admixtures may not be usable in mixtures that require NSF 61 certification.
Mineral Coloring	Not Used.
Fibers	Not Used.

2-3. MIXTURE DESIGN AND TESTING. As stipulated in the Quality Control section, all reports and tests required for preliminary review of materials and for laboratory trial mixtures shall be made by an independent testing laboratory at the expense of Contractor. Mixtures shall be adjusted in the field as necessary, within the limits specified, to meet the requirements of these specifications. If the source of any concrete materials is changed during the contract, concrete work shall pause until the new materials and the new mixture design are tested in accordance with the specified requirements.

2-3.01. Preliminary Review of Materials. The tests and reports required shall be as indicated in Table 2A. Review of these reports shall be for general acceptability only, and continued compliance with all contract provisions shall be required.

Aggregate reports shall be no more than 90 days old at time of submittal.

Alkali-aggregate reactivity potential shall be determined by one of the following procedures. A satisfactory service record evaluation as described in ASTM C33 will not be acceptable.

1 Test fine and coarse aggregates in accordance with ASTM C1260. Aggregates which are classified as innocuous may be used without further testing. Aggregates which are not innocuous shall be further tested in accordance with ASTM C227 or C1105 (as appropriate), using a cement containing less than 0.6 percent alkalies.

2 Test fine and coarse aggregates in accordance with ASTM C1567, using a single aggregate with all cementitious materials selected for the Project. The fine and coarse aggregates shall not be combined and used in a single test. This test may only be used for mixtures that contain slag cement or fly ash, and those products shall not have an alkali content greater than 4.0 percent sodium oxide equivalent. Combinations of cementitious materials and aggregate which do not indicate a potential for alkali reactivity may be used without further testing. Mixture combinations which indicate a potential for alkali reactivity shall have the ingredients and/or proportions modified and then the test shall be repeated.

3 Test fine and coarse aggregates in accordance with ASTM C1293. Concrete mixtures containing only portland cement (without pozzolan or slag cement) shall be tested accordingly and have a measured expansion of 0.04 percent or less at one year duration. Concrete mixtures containing pozzolan or slag cement shall be tested with those ingredients in proportions matching that of the proposed mixture, and shall have a measured expansion of 0.04 percent or less at two years duration.

At the discretion of Engineer, testing in addition to that indicated herein or in Appendix X1 of ASTM C33 may be performed on potentially reactive aggregates. Nonreactive aggregates shall be imported if, in the opinion of Engineer, local aggregates exhibit unacceptable potential reactivity.

2-3.02. Proposed Mixture Proportions. Proposed proportions for each Class of concrete shall meet the limiting requirements indicated herein.

2-3.03. Mixture Testing. Test results on each Class of concrete shall be submitted for review and shall be acceptable to Engineer before concrete work is started. The reports shall include the information indicated in Table 2C.

2-3.03.01. Field Test Record Data. If indicated as acceptable in Table 2C, concrete mixtures may be qualified based upon field test record performance data in lieu of laboratory trial mixtures. Field test data records shall be from the production facility being used on the current Project and shall have been performed in the past 12 months. Field test records shall represent a single

group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days.

2-3.03.02. Laboratory Trial Mixture Testing. Trial mixtures shall be tested in the laboratory for each size and combined gradation of aggregates and for each consistency as indicated and intended for use on the work and as specified.

Concrete ingredients shall be measured and mixed in the laboratory. Concrete test specimens shall be made, cured, and stored in accordance with ASTM C192 and tested in accordance with ASTM C39.

Concrete proportions shall be established based on laboratory trial mixtures that meet the following requirements:

a. The combination of materials shall be as proposed for use in the work.

b. Mixtures shall conform with the limiting requirements specified herein.

c. The required average compressive strength, f'_{cr}, of the trial mixture shall exceed the specified minimum acceptable compressive strength, f'_{cr}, as required in Table 1.

d. Trial mixtures of the proportions and consistencies specified for the work shall be prepared. When a three point curve is required by Table 2C, the three concrete trial mixtures shall reflect the cement content proposed for the Project and for the indicated concrete class at three water-cementitious material ratio contents at or lower than indicated in Table 1. The compressive strength of the cylinders made from the three trial mixtures shall produce a range of compressive strengths exceeding or encompassing the f'_{cr} required for the work.

e. For each proposed concrete mixture that is required to be tested as indicated in Table 2C, compressive strength test cylinders shall be made for each testing age. Each change in the water-cementitious materials ratio shall be considered a new concrete mixture. Each mixture shall be tested at the ages of 7 days and 28 days.

f. When a three point curve is required in Table 2C, the results of the cylinder tests for each water-cementitious materials ratio at each

age shall be plotted as a curve showing the relationship between compressive strength (along y-axis) and the water-cementitious materials ratio (along x-axis). The water-cementitious materials ratio and the associated average compressive strength for the Project concrete mixture shall be selected from the 28 day curve. The maximum water-cementitious materials ratio specified in the limiting requirements shall still apply even if the curve indicates that the concrete strength would be adequate at a higher ratio. The cement content and mixture proportions to be used shall be such that the selected water-cementitious materials ratio will not be exceeded at specified maximum slump. These concrete mixture proportions shall be submitted for review in accordance with the Submittals Procedures section.

g. When a shrinkage reducing admixture is proposed, trial mixtures shall be prepared with and without the shrinkage reducing admixture.

2-3.03.03. Testing Procedures. Concrete mixture testing procedures shall be as specifier herein, and reports for these tests shall be prepared specifically for this Project.

Aggregates shall be sampled and tested in accordance with ASTM C33. The bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM C128.

Slump shall be determined in accordance with ASTM C143. Unit weight (mass) shall be determined in accordance with ASTM C138. Total air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138. Concrete temperature shall be determined in accordance with ASTM C1064.

Initial set tests shall be made at ambient temperatures of 70°F and 90°F to determine compliance with the specified time for initial set. The test at 70°F shall be made using concrete containing the specified normal set/water-reducing admixture and, when required, air-entraining admixture. The test at 90°F shall be made using concrete containing the specified retarding/water-reducing admixture and, when required, air-entraining admixture. Initial set shall be determined in accordance with ASTM C403.

Cylinders shall be 6 inches diameter by 12 inches high for concrete mixes using a maximum nominal aggregate size of 1 inch or larger. Cylinders may be either 6 inches diameter by 12 inches high, or 4 inches diameter by 8 inches high for concrete mixes using a maximum nominal aggregate size of less than 1 inch .

The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch diameter cylinders, and at least two cylinders when using 6 inch diameter cylinders. All tests for a particular class of concrete shall be performed using the same sized cylinders for the duration of the work.

Water-soluble chloride ion shall be determined in accordance with ASTM C1218.

A drying shrinkage test shall be conducted on the trial mixture with the maximum water-cementitious materials ratio used to qualify each proposed concrete mixture design using the concrete materials, including admixtures, that are proposed for the Project. Three test specimens shall be prepared for each test. Drying shrinkage specimens shall be 4 inch by 4 inch by 11 inch prisms with an effective gauge length of 10 inches , fabricated, cured, dried, and measured in accordance with ASTM C157 except with the following modifications:

Specimens shall be removed from the molds at an age of 23 hours ±1 hour after batching, shall be placed immediately in water at 73°F ±3°F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in lime-saturated water as specified in ASTM C157. Measurement to determine expansion expressed as a percentage of original length shall be taken at age 7 days. The length at 7 days shall be the base length for drying shrinkage calculations ("zero" days drying age). Specimens then shall be stored immediately in a humidity controlled room maintained at 73°F ±3°F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as a percentage of the base length shall be reported separately for 7, 14, and 21 days ±4 hours of drying from "zero" days after 7 days of moist curing for a total of 28 days from the date of casting.

Drying shrinkage deformation for each specimen shall be computed as the difference between the base length (at "zero" days drying age) and the length after drying at each test age. Results of the shrinkage test shall be reported to the nearest 0.001 percent. If drying shrinkage of any specimen deviates from the average for that test age by more than 0.004 percent, the results for that specimen shall be disregarded.

The average drying shrinkage of each set of 4 inch by 4 inch by 11 inch test specimens made in the laboratory from a trial mixture shall not exceed the values required in Table 1.

NSF/ANSI 61 compliance shall be demonstrated in accordance with mechanisms outlined in Standard 61 but typically will require a site mix evaluation. The site mix evaluation shall be coordinated with the laboratory activities associated with the other limiting requirements of this section. An ANSI accredited certification report shall be submitted for each applicable concrete mixture, along with a compliance evaluation for each concrete structure providing containment.

2-4. ARCHITECTURAL CONCRETE. Architectural concrete shall be used only where indicated on the drawings, and shall conform to the applicable requirements of Section 6 of ACI 301.

PART 3 – EXECUTION

3-1. BATCHING, MIXING, AND DELIVERY. Concrete shall be furnished by an acceptable ready-mixed concrete supplier.

3-1.01. General. Mixing plants shall comply with ASTM C 94 and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet construction schedule. All plant facilities are subject to inspection by the Independent Testing Laboratory and acceptance of the Engineer.

Mixing:

1. Mix concrete with an approved rotating type batch machine.

2. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.

3. Replace mixer blades when they have lost 10 percent of their original height.

4. Plant equipment and facilities: Conform to National Ready Mix Concrete Association "Plant and Delivery Equipment Specification".

5. Mix concrete in revolving type truck mixers, which are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.

6. Do not exceed the proper capacity of the mixer.

7. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.

8. Do not allow the drum to sit while in transit.

9. Mix at proper speed until concrete is discharged.

10. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.

11. The Contractor shall ensure that the silica fume is uniformly dispersed throughout the concrete in accordance with mixing procedures recommended by the silica fume supplier.

3-1.02. Transporting Concrete.

1. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients, except as noted in Section 02425.

2. Take care to avoid spilling and separation of the mixture during transportation.

3. Do not place concrete in which the ingredients have been separated.

4. Do not retemper partially set concrete, and do not add any water at the jobsite.

5. Use suitable and approved equipment for transporting concrete from mixer to forms.

6. For Tunnel and Shaft permanent lining, refer to Section 02425

3-1.03. Delivery Tickets. A delivery ticket shall be prepared for each load of ready-mixed concrete and a copy of the ticket shall be handed to Engineer by the truck operator at the time of delivery. Tickets shall indicate the name and location of Contractor, the project name, the mixture identification, the quantity of concrete delivered, the quantity of each material in the batch, the outdoor temperature in the shade, the time at which the cementitious materials were added, and the numerical sequence of the delivery.

3-1.04. Mixing Water. Mixing water shall not be added in transit. Any amount of water withheld from the truck mixer shall be clearly indicated on the delivery ticket. Water added at the site shall not exceed the amount withheld, and shall not be added without oversight by Owner's on site inspector.

3-1.05. Consistency. The consistency of concrete shall be suitable for the placement conditions. Aggregates shall flow uniformly throughout the mass, and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

3-2. CONTRACTOR'S ON GOING MATERIAL CONTROL TESTING. The following tests and test reports are required during the progress of the work and shall be made at the expense of Contractor. The frequency specified herein for each field control test is approximate and subject to change as determined by Engineer.

3-2.01. Aggregate Gradation. Each 200 tons of fine aggregate and each 400 tons of coarse aggregate shall be sampled and tested in accordance with ASTM D75 and C136, for verification that the gradations continue to meet ASTM C33 requirements. If lesser quantities of aggregates are used, the sampling and testing shall occur at least once every 6 months.

3-2.02. Sand Equivalent. The sand equivalent test shall be conducted each time the sand gradation tests are conducted.

3-2.03. Fly Ash. Each 400 tons of fly ash shall be sampled and tested in accordance with ASTM C618 and C311. Contractor shall supply Engineer with certified copies of supplier's (source) test reports showing chemical composition and physical analysis for each shipment delivered to Contractor and certifying that the fly ash complies with the specifications. The certificate shall be signed by the fly ash supplier.

3-2.04. Cement. Each 1500 tons of cement shall be sampled and tested in accordance with ASTM C150. Contractor shall supply Engineer with certified copies of supplier's (source) test reports showing chemical composition and physical analysis, and certifying that the cement complies with ASTM C150 and these specifications. The certificate shall be signed by the cement manufacturer.

3-2.05. Slag Cement. Each 800 tons of slag cement shall be sampled and tested in accordance with ASTM C989. Contractor shall supply Engineer with certified copies of supplier’s (source) test reports showing chemical composition and physical analysis, and certifying that the slag cement complies with ASTM C989 and these specifications. The certificate shall be signed by the slag cement manufacturer.

3-3. OWNER'S FIELD CONTROL TESTING. Field control tests, including slump, air content, and making compression test cylinders, shall be performed by Engineer or Owner’s testing laboratory personnel, at the expense of Owner.

Contractor shall provide access to all facilities and the services of one or more employees as necessary to assist with the field control testing.

The frequency specified herein for each field control test is approximate and subject to change as determined by Engineer.

Engineer may require field testing prior to the addition of superplasticizer at the Site to determine compliance with the specifications. Field testing after the addition of superplasticizer shall be conducted as specified and as needed to determine that the concrete is in compliance with the specifications. Air content tests shall be conducted whenever field tests are conducted.

3-3.01. Slump. A slump test shall be made for each 100 cubic yards of concrete. Slump shall be determined in accordance with ASTM C143.

3-3.02. Air Content. An air content test shall be made on concrete from one of the first three batches mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138.

3-3.03. Unit Weight. A unit weight test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. Unit weight shall be determined in accordance with ASTM C138.

3-3.04. Concrete Temperature. A concrete temperature test shall be made on concrete from the first batch of concrete mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. During hot or cold weather concreting operations, temperature shall be checked not less than once per hour. Concrete temperature shall be determined in accordance with ASTM C1064.

3-3.05. Water-Soluble Chloride Ion. Water-soluble chloride ion testing shall be performed once for each 1,000 cubic yards of concrete in accordance with ASTM C1218.

3-3.06. Compression Tests. One set of concrete compression test cylinders shall be made not less than once each day concrete is placed, not less than once for each 100 cubic yards of each class of concrete, and not less than once for each 5000 square feet of surface area for slabs or walls. Each set of test cylinders requires at least five standard test cylinders. Two cylinders shall be broken at seven days and will be used as an aid in determining the early strength of the concrete. Two cylinders shall be tested at 28 days and shall comprise a

strength test under the definition of these Specifications. The remining cylinder shall be retained in reserve for later testing if required..

Test cylinders shall be made, cured, stored, and delivered to the laboratory in accordance with ASTM C31 and tested in accordance with ASTM C39.

Cylinders shall be 6 inches diameter by 12 inches high for concrete mixes using a maximum nominal aggregate size of 1 inch or larger. Cylinders may be either 6 inches diameter by 12 inches high, or 4 inches diameter by 8 inches high for concrete mixes using a maximum nominal aggregate size of less than 1 inch . The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch diameter cylinders, and at least two cylinders when using 6 inch diameter cylinders. All tests for a particular mixture class shall be performed using the same sized cylinders for the duration of the work and shall match the cylinder size used for the trial mixtures.

Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the number of the delivery truck or batch, the air content, the slump, the unit weight, and the concrete temperature.

3-3.07. Shrinkage Tests. Concrete shrinkage tests shall be performed once for each 1,000 cubic yards of concrete with controlled shrinkage that is placed and shall be made on concrete from a batch of concrete from which concrete compression test cylinders are made. Shrinkage testing shall be conducted as specified for the preliminary trial mixtures.

The average drying shrinkage of each set of test specimens cast in the field from concrete delivered to the Site and sampled at the end of the delivery truck chute, as measured at the 21 days drying age, shall not exceed the values indicated in Table 1.

3-3.08. Test Reports. Five copies of each test report shall be prepared and distributed by the testing laboratory to the Owner, Resident Project Representative (two copies), Engineer, and Contractor, in accordance with the Quality Control section.

3-4. EVALUATION AND ACCEPTANCE OF CONCRETE. Concrete will be evaluated for compliance with all requirements of the specifications. Concrete strength will be only one of the criteria used for evaluation and acceptance of the concrete. The results of all tests performed on the concrete and other data and information concerning the procedures for handling, placing, and curing concrete will be used to evaluate the concrete for compliance with the specified

requirements.

Compression tests will be evaluated in accordance with ACI 318 and as specified herein. A strength test shall be the average of the compressive strengths of two 6 inch diameter cylinders or three 4 inch diameter cylinders, made from the same concrete sample tested at 28 days.

3-4.01. Compression Test Evaluation. Compressive strength test results will be evaluated for compliance with the specified strength requirements. The strength level of the concrete will be considered satisfactory when the averages of all sets of three consecutive strength tests equal or exceed the specified compressive strength, f'_c, and no individual strength test result falls below the specified compressive strength by more than 500 psi .

3-4.02. Faulty Concrete. Failure to comply with any of the specified conditions shall constitute faulty concrete. Unless otherwise directed by the Engineer, faulty concrete shall be removed and replaced with concrete as specified, at no expense to the Owner.

3-4.03. Additional Test. If permitted by the Engineer, additional tests shall be subject to the approval of the Engineer at no expense to the Owner. Load tests, if permitted by the Engineer, shall be conducted in accordance with the loading criteria as required by the design of the structure, as determined by the Engineer.

3-4.04. Inspection of Concrete Supplier. Both scheduled and unscheduled visits by inspectors on days of concrete pours shall be accommodated. Inspectors shall be allowed access to delivery tickets and mixture proportions.

3-4.05. Classification and Strength. Neither the results of laboratory verification tests nor any provision in the Contract Documents shall relieve the Contractor of the obligation to furnish concrete of the class and strength specified.

TABLE 1 – LIMITING REQUIREMENTS															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1.	**Minimum Cement Content**, lbs/cubic yard; based on maximum slump and maximum water-cementitious material ratio.														
	Maximum Nominal Aggregate Size, ASTM C33 aggregate														
	Size No. 467 (1-1/2")	---	---	489	---	440	464	---	---	600*	**	---	---	---	380
	Size No. 57 (1")	536	---	514	---	460	489	514	460	620*	**	---	---	---	400
	Size No. 67 (3/4")	564	---	526	---	480	514	526	480	640*	**	---	---	526	420
	Size No. 7 (1/2")	---	601	555	---	500	526	555	500	660*	**	---	584	555	440
	Size No. 8 (3/8")	---	636	564	---	520	555	564	520	680*	**	636	601	564	460
	Fine Aggregate, (Sand)	---	---	---	750	---	---	---	---	---	---	---	---	---	---
2.	**Compressive Strength**, minimum; psi														
	Field, 7 days;	3375	3375	3375	3000	3000	3000	3000	2250	3000	**	3000	3000	3000	1500
	Field, 28 days; f'_c	4500	4500	4500	4000	4000	4000	4000	3000	4000	**	3000	4000	4000	2000
	Laboratory, 28 days; f'_{cr}	5700	5700	5700	5200	5200	5200	5200	3200	5200	**	4200	5200	5200	2000
3.	**Maximum water-cementitious material ratio**	0.42	0.42	0.45	0.45	0.45	0.48	0.45	0.65	0.45	**	0.45	0.45 0.40[a]	0.42	0.75
4.	**Maximum nominal coarse aggregate size, inches**	1	1/2	1-1/2	Sand	1-1/2	1-1/2	1	1	1-1/2	**	3/8	1/2	3/4	1-1/2
5.	**Maximum slump**, inches														
	Slump before super-plasticizer added	3	3	4	6	6	4	3	5	6	**	4	4	4	6

TABLE 1 – LIMITING REQUIREMENTS															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
	Slump after adding superplasticizer	8	8	8	8	8	8	8	8	9	**	8	8	8	10
6.	**Total air content**, percent, (± 1.5 %)	6	6	6	6	6	6	6	---	---	**	---	6	6	---
7.	**Fly ash replacement, percent range**	15-25	15-25	15-25	15-25	15-30	15-25	15-25	15-30	15-25	**	15-30	15-35	15-25	15-30
8.	**Slag cement replacement, percent range**	25-50	25-50	25-50	0	25-50	25-30	0	25-50	0	**	0	0	25-50	25-50
9	**Testing limits**														
	Sand equivalent, min. percent	75	75	75	75	75	75	75	---	75	**	75	75	75	---
	Chloride ion, max. percent	0.10	0.10	0.15	0.10	0.30	0.15	0.10	0.30	0.30	**	---	0.15	0.15	---
	Shrinkage, max. percent; based 4 x 4 x 11 inch specimen														
	Laboratory	0.036	0.036	0.048	---	---	0.048	0.048	---	0.048	**	---	---	0.048	---
	Field	0.048	0.048	0.064	---	---	0.064	0.064	---	0.064	**	---	---	0.064	---
	Coarse Aggregate: Clay and shale combined particles shall not exceed, max. percent	1	1	1	1	1	3	2	10	1	**	3	1	2	3
10	**Concrete temperature at time of delivery and placement, max. °F**	85	85	90	85	90	95	85	95	95	**	90	85	85	95

NOTES:
* "D2" (Underwater concrete) - Limit aggregate to 3/4" for reinforced concrete, up to 1-1/2" for unreinforced concrete.
** "D3" (Mass Concrete) limiting requirements shall be as indicated in the Mass Concrete section.
[a] "D5" Wash water trough top edge water-cementitious ratio, 100 percent sand passing No. 8 sieve.

TABLE 2A – SUBMITTAL REQUIREMENTS (PRELIMINARY REVIEW OF MATERIALS)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1	**Aggregate reports** (ASTM C33)														
	Fine aggregate														
	Source and type	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Gradation	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Deleterious materials	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Fineness modulus	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	X	X	X	X	X	X	**	---	X	X	X
	Sand equivalent	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Coarse aggregate														
	Source and type	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Gradation	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Deleterious materials	X	X	X	---	X	X	X	X	X	**	X	X	X	---
	Abrasion loss	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Soundness test	X	X	X	---	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	---	X	X	X	X	X	**	---	X	X	X
	Combined aggregate gradation	X	X	X	---	X	X	X	X	---	**	X	---	---	---
2	**Cement**, mill report	X	X	X	X	X	X	X	X	X	**	X	X	X	X

TABLE 2A – SUBMITTAL REQUIREMENTS (PRELIMINARY REVIEW OF MATERIALS)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
3	**Cementitious material**, type, data sheet, and test report (fly ash, slag cement)	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**	**X**	**X**	**X**	**X**
4	**Admixtures**														
	Data sheets and certifications	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**	**X**	**X**	**X**	**X**
	Manufacturer's approval letter	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**	**X**	**X**	**X**	**X**
5	**NSF 61 compliance**, for each proposed concrete constituent, where applicable	**X**	**X**	---	---	---	---	---	**X**	---	**	---	---	---	---

TABLE 2B – SUBMITTAL REQUIREMENTS (PROPOSED MIXTURE PROPORTIONS)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
5	**Mixture proportions**, reports	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**	**X**	**X**	**X**	**X**

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
6	**Type of testing**														
	Field test records acceptable	---	---	---	---	---	---	---	**X**	---	**	**X**	**X**	**X**	**X**
	Trial mixtures required	**X**	**X**	**X**	**X**	**X**	**X**	**X**	---	**X**	**	---	---	---	---
7	**Test Reports Required**														
	Confirmation of materials tested														
	Cement brand, type, composition, quantity	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**	**X**	**X**	**X**	---
	Fly ash brand, type, composition, quantity	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**	**X**	**X**	**X**	**X**
	Specific gravity of each aggregate	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**	**X**	**X**	**X**	**X**
	Ratio of fine to total aggregates	**X**	**X**	**X**	---	**X**	**X**	**X**	---	---	**	---	**X**	**X**	---

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
	Water content	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Water-cementitious materials ratio	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Slump	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Unit weight	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Air content	X	X	X	---	X	X	X	---	---	**	---	X	X	---
	Temperature	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Time of initial set at 70°F and 90°F.	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Three point curves	X	X	X	---	---	---	X	---	X	**	---	---	---	---
	Compressive strength at 7 and 28 days	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Water-soluble chloride ion	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Drying shrinkage	X	X	X	---	---	X	X	---	X	**	---	---	X	---
	NSF 61 compliance evaluations where applicable	X	X	---	---	---	---	---	X	---	**	---	---	---	---

NOTES:
** "D3" (Mass Concrete) submittal requirements shall be as indicated in the Mass Concrete section.

End of Section

Section 03350

CONCRETE PLACING, FINISHING, AND CURING

PART 1 – GENERAL

1-1. SCOPE. This section covers placing, finishing, and curing of cast-in-place concrete.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1-2. GENERAL. All cast-in-place concrete shall be accurately formed and properly placed, finished, and cured as indicated on the Drawings and as specified herein.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. All submittals of test data, manufacturers' certificates of compliance, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

1-3.02. Manufacturer's Certificate of Compliance. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

Membrane curing compound and floor sealer.

Epoxy bonding agent.

PART 2 - PRODUCTS

2-1. LIMITING REQUIREMENTS. Concrete shall be handled, placed, and cured in a manner that will minimize shrinkage and cracking as specified herein. Concrete temperatures shall be controlled both before and after placement to minimize cracking.

2-2. MATERIALS.

Concrete Surface Coloring/Hardener	Mineral aggregate dry-shake colored hardener for concrete flatwork. ChemSystems, Inc. “CSI Heavy -Duty Color Hardener”, Euclid “Surflex”.
Evaporation Reducer	Dayton Superior "AquaFilm Concentrate J74", Euclid "Eucobar", L&M Chemical "E-Con", BASF "Confilm", or Sika "SikaFilm".
Epoxy Bonding Agent	ASTM C881, Type V, moisture insensitive, 100 percent solids; BASF "Concresive Paste LPL" , Euclid "Euco #352 or #452"or Prime Resins “Prime Bond”.
Membrane Curing Compound and Floor Sealer	ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, non-yellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

2-3. ARCHITECTURAL CONCRETE. Not Used.

PART 3 - EXECUTION

3-1. RECEIVING. Contractor shall check each delivery ticket to verify the concrete class delivered to the jobsite is in compliance with the concrete requested and is suitable for Contractor's handling, placing, finishing, and curing procedures. Engineer shall collect the delivery tickets from the truck operator.

3-2. PLACEMENT. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer. All concrete within the predetermined limits shall be placed in one continuous operation.

Before concrete is placed, forms, reinforcement, water stops, anchor bolts, and embedments shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow from within the formwork before concrete is placed.

Contractor shall inform Engineer at least 24 hours in advance of the times and places at which he intends to place concrete.

3-2.01. Bonding to Hardened Concrete. The surface of hardened concrete upon which fresh concrete is to be placed shall be rough, clean, sound, and damp. Before placement of plastic concrete, the hardened surface shall be cleaned of all laitance and foreign substances (including curing compound). Brush blast new and existing concrete surfaces at joint and surrounding area. Dry, oil-free air to be used for blasting operation. Blasting to be sufficient to remove laitance and solid contaminants, open up surface voids, bugholes, air pockets and other subsurface irregularities but not expose underlying aggregate. The abrasive to shall be dry and clean and will pass through a 16 mesh screen. After blast cleaning is completed, residual abrasive dust and loose particles are to be removed from the surface by vacuuming or by compressed air. Blasting operation is to be repeated if requested by the Engineer at no additional compensation to the Contractor. Wash new and existing concrete surfaces with clean water, wetted thoroughly, and the surface made free of standing water. Surface profile of the hardened concrete after surface preparation shall be as required for good bond.

Coarse aggregate shall be omitted from the first batch or batches of concrete placed on hardened concrete in wall or column forms. The mortar puddle, Class A4 concrete, shall cover the hardened concrete by at least 2 inches [50 mm] at every point.

3-2.02. Conveying Concrete. Methods of conveying concrete to the point of final deposit shall prevent segregation or loss of ingredients. After placement in the forms, concrete shall not be moved laterally more than 5 feet [1500 mm]. Concrete's free fall should not exceed 4 feet [1200 mm].

3-2.03. Pumping Concrete. The slump of concrete, with or without a superplasticizer, that is discharged into the pump may exceed the specified maximum slump value by the amount of slump loss in the pumping system, up to a maximum of 1 inch [25 mm]. The slump loss shall be determined by tests made at each end of the pumping system. If tests indicate a slump loss greater than 1 inch [25 mm] in the pumping system, Contractor shall modify the pumping system as required to reduce the slump loss to 1 inch [25 mm] or less.

3-2.04. Placing Concrete. For proper compaction, concrete shall be placed in approximately horizontal layers not to exceed 24 inches [600 mm]. Each layer of concrete shall be plastic when covered with the following layer, and the rate of vertical rise of the concrete in the forms shall be not less than 24 inches [600 mm] per hour. Vertical construction joints shall be provided as necessary to comply with these requirements.

Concrete shall be placed and compacted in wall or column forms before any reinforcement is placed in the system to be supported by such walls or columns. The height of any portion of a wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet [1800 mm]. Concrete in walls or columns shall settle at least

2 hours before concrete is placed in the structural systems to be supported by such walls or columns.

Concrete shall be thoroughly settled before top finishing. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.

Concrete for piers or caissons shall be carefully deposited to avoid contact with forms, reinforcement, and earth sides until completion of the drop. Necessary precautions shall be taken during concrete placement to prevent earth or other material from falling into excavations and to avoid dislocation of reinforcement. Concrete shall be placed continuously to the top of each pier or caisson at a rate of not less than 2 feet [600 mm] of vertical rise per hour. Forms above grade shall be of cylindrical steel or fiber acceptable to Engineer.

3-2.05. Compaction. During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcement and embedments and into the corners of the forms. Mechanical vibrators shall maintain at least 14,000 cycles per minute when immersed in the concrete. The number and type of vibrators shall be acceptable to Engineer. The use of "jitterbug" tampers to compact concrete flatwork will not be permitted.

3-2.06. Cold Weather Concreting. Except as modified herein, cold weather concreting shall comply with ACI 306.1.

Massive embedded items identified on the drawings shall be above 32°F [0°C] when the concrete is placed.

When placed, heated concrete shall not be warmer than 80°F [26°C]. When freezing temperatures may be expected during the curing period, the concrete surface shall be maintained at a temperature of at least 50°F [10°C] for 5 days or 70°F [21°C] for 3 days, after placement. Concrete temperature shall be recorded at least six times for each 24 hour period. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

3-2.07. Hot Weather Concreting. Except as modified herein, hot weather concreting shall comply with ACI 305.1.

At air temperatures of 90°F [32°C] or above, concrete shall be kept as cool as practicable during placement and curing. The temperature of the concrete when placed in the work shall not exceed the values indicated in the Cast-in-Place Concrete section.

Plastic shrinkage cracking due to rapid evaporation of moisture shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 lb per square foot per hour [1 kg/m^2/h], as determined using the nomograph in Appendix A of ACI 305.1.

3-2.08. Placement Sequence. To minimize the effect of shrinkage in producing cracks, the following structures shall be constructed using a placement sequence:

a. Primary Clarifiers
b. Transfer Pump Station
c. Primary Headhouse
d. Primary Clarifiers Junction Box

For these structures, concrete shall be placed as follows:

Bottom Slab. Each bottom slab shall be divided into sections by the construction joints indicated on the Drawings and, when not indicated on the Drawings, into approximately square sections not greater than 60 feet [18 m] in their longest dimension. Bottom slabs with radial and circumferential reinforcement patterns may be divided into pie-shaped segments with the longest dimension not greater than 60 feet [18 m]. A section near the center of each structure shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of previously placed sections. Placement shall be scheduled so that two adjacent sides of each section are free, except at closures.

Walls. Walls shall be divided into sections by the construction joints indicated on the Drawings and, when not indicated on the Drawings, into sections not greater than 60 feet [18 m] in length. A section near the center of each wall shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of the previously placed section. Placement shall be scheduled so that one end of each section is free, except at corner closures.

Top Slab. Each top slab shall be placed in the manner described for the bottom slab.

No two abutting sections shall be placed within a period of 48 hours, unless otherwise authorized by Engineer.

3-2.09. Duct Banks. Duct bank concrete shall be compacted by rodding or spading only. Mechanical vibrators shall not be used. Concrete shall be worked around reinforcement and embedments and into the corners of the forms.

3-2.10. Underwater Concrete. Underwater (tremie) concrete, if used, shall be deposited underwater within the construction limits indicated on the Drawings. Concrete shall not be deposited underwater without the concurrence of Engineer.

Underwater concrete shall be placed using methods described in ACI 304R through tremies having hoppers at the upper end.

The water shall be quiescent when concrete is deposited. Velocity of flow within the space where the concrete is placed shall not exceed 2 feet per minute [600 mm/min] in any direction. After concrete is placed, the water level in the space shall be kept static until the concrete has hardened.

3-3. FINISHING UNFORMED SURFACES. Buried and permanently submerged concrete blocking and encasement will require no finishing except as necessary to obtain the required surface elevations or contours. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

3-3.01. Screeding. Screeding shall produce a concrete surface conforming to the proper elevation and contour, with all aggregates completely embedded in mortar.

3-3.02. Application of Evaporation Reducer. Concrete flatwork subject to rapid evaporation due to hot weather, drying winds, and sunlight shall be protected with an evaporation reducer. The evaporation reducer shall form a continuous film on the surface of fresh, plastic concrete to reduce evaporation.

Immediately following screeding, evaporation reducer shall be sprayed over the entire surface of fresh, plastic concrete flatwork at a rate of not less than 200 square feet per gallon [4 m^2/L], in accordance with the manufacturer's recommendations. The spray equipment shall have sufficient capacity to continuously spray the product at approximately 40 psi [275 kPa] with a suitable nozzle as recommended by the manufacturer.

The sprayable solution shall be prepared as recommended by the manufacturer.

Under severe drying conditions, additional applications of evaporation reducer may be required following each floating or troweling, except the last finishing operation.

3-3.03. Floating. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color, and unless additional finishing is specifically required, shall produce the completed finish for unformed surfaces.

Floating shall be done with hand floats or suitable mechanical compactor-floats.

3-3.04. Finishing Surfaces for Bonding. All surfaces to be covered with concrete or topping shall be float finished. All laitance, surface mortar, and unsound material shall be removed by brushing or air blasting at the time of initial set. Surfaces shall be rough, clean, and sound. Floors and other flat surfaces to receive composite topping (Class D6) shall be given a broom finish or raked finish with at least a 1/4 inch [6 mm] profile.

3-3.05. Troweling. Interior floor surfaces which will be exposed after construction is completed; surfaces to be covered with resilient floor coverings, thinset terrazzo, or seamless floor covering; exposed top surfaces of equipment bases and interior curbs; and other surfaces designated on the Drawings shall be steel trowel finished. Surfaces to be covered with elastomeric deck covering shall be lightly troweled but not burnished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

3-3.06. Edging. Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having at least a 1/8 inch [3 mm] corner radius.

3-3.07 Broom Finish. Not Used.

3-3.08. Nonslip Aggregate Finish. Not Used.

3-3.09. Pavement Finishing. Not Used.

Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be drag finished, using a seamless strip of damp burlap over the full width of the surface. The burlap drag shall consist of sufficient layers of burlap and shall have sufficient length in contact with the concrete to slightly groove the surface. The drag shall be moved forward with a minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. When acceptable to Engineer, carpet, artificial turf, or cotton fabric may also be used.

3-3.10. Curb and Gutter Finishing. Curb and gutter shall be finished to the shape indicated on the Drawings. After the forms have been removed, all exposed edges shall be rounded, using an edging tool with at least a 1/8 inch [3 mm] corner radius. Exposed surfaces shall be float finished and given a light broom finish applied at right angles to the curb at the time of initial set, using a horsehair type broom.

3-3.11. Sidewalk Finishing. Not Used.

3-4. CONCRETE SURFACE COLORING/HARDENER. Where concrete surface coloring/hardener is required, a dry-shake coloring material shall be worked into the freshly screeded concrete surface.

3-4.01. Duct Bank Finishing. After screeding and before final floating, a red concrete surface coloring shall be dusted onto the fresh concrete surface at the rate recommended by the manufacturer.

3-5. MINERAL COLORED CONCRETE. Not Used.

3-6. FLOOR SEALER. All concrete floors which are subject to foot traffic and are not required to be covered with resilient floor coverings, thinset terrazzo, seamless flooring, ceramic tile, or quarry tile shall be given two coats of clear floor sealer in addition to any which may have been applied as membrane curing compound. Prior to application of each coat of sealer, the floor shall be thoroughly cleaned of dirt, grease, and other foreign matter. The first coat shall be applied at the end of the curing period and before any traffic is permitted on the floor. The second coat shall be applied in preparation for substantial completion of the work. Floor sealer shall be applied in accordance with the manufacturer's recommendations.

3-7. CURING. Concrete shall be protected from loss of moisture for at least 7 days after placement unless indicated otherwise. Curing of concrete shall be done by methods which will keep the concrete surfaces adequately wet for the specified curing period.

3-7.01. Water Curing. Water curing shall be performed for concrete in liquid-containing structures and for all concrete containing slag cement. Other forms of curing will not be acceptable in these applications. Water curing shall be in accordance with ACI 308.1 except as modified herein.

Water saturation of concrete surfaces shall begin as soon as possible after initial set. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

Water curing shall continue for 14 days for concrete containing slag cement, and for 7 days for other types of concrete. However, when concrete is being protected from low temperatures, the duration of water curing may be shortened to 1 day less than the duration of cold weather protection.

When forms are removed before the specified curing duration is completed, measures shall be taken to immediately continue curing and to provide adequate thermal protection for the concrete.

3-7.02. Membrane Curing. Unless otherwise specified, membrane curing compound may be used instead of water curing on concrete in non-liquid-containing structures which will not be covered later with topping, mortar, coating, or additional concrete.

Membrane curing compound shall be evenly sprayed at a coverage rate of not more than 300 square feet per gallon [7.3 m^2/L]. The spray equipment shall have sufficient capacity to continuously spray curing compound at approximately 40 psi [275 kPa] with a suitable nozzle as recommended by the manufacturer. Unformed surfaces shall be covered with the first coat of curing compound within 30 minutes after final finishing. A second coat of curing compound shall be applied when the first coat has become tacky to the touch and shall be applied at right angles to the first coat. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces.

Concrete surfaces shall be covered with white polyethylene sheeting immediately after the curing compound has become dry to the touch. White polyethylene sheeting shall completely cover the surfaces and shall overlap the edges for proper sealing and anchorage. Joints between sheets shall be sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges, and shall be anchored as necessary to prevent billowing on the surface.

Curing compound shall be suitably protected against abrasion during the curing period.

3-7.03. Film Curing. Unless otherwise specified, film curing with white polyethylene sheeting may be used instead of water curing on concrete in nonliquid-containing structures which will be covered later with mortar or additional concrete, or which will otherwise not be exposed to view.

Film curing shall begin as soon as possible after initial set of the concrete. The concrete surfaces shall be completely covered with polyethylene sheeting. Sheeting shall overlap the edges of the concrete for proper sealing and anchorage, and joints between sheets shall be sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and as necessary to prevent billowing on the surface.

3-8. REPAIRING DEFECTIVE CONCRETE. Defects in formed concrete surfaces shall be repaired to the satisfaction of Engineer within 24 hours of form removal. Surface repair work shall conform to Article 5.3.7 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of the surrounding concrete. Surface repair material shall be adequately cured.

Defects in concrete that are more than 3 inches [75 mm] deep shall be brought to the attention of Engineer prior to any repair work. Contractor shall submit a proposed repair material and procedure for review by Engineer. The repair material and procedure

required by Engineer may be more extensive than the process described in Article 5.3.7 of ACI 301.

3-9. FINISHING FORMED SURFACES. Fins and other concrete surface projections shall be removed from all formed surfaces, except exterior surfaces that will be in contact with earth backfill and are not specified to be dampproofed. A power grinder shall be used, if necessary. Surfaces to be dampproofed shall have fins removed and tie holes filled, but no additional finishing will be required.

3-9.01. Tie Holes. Tie holes in formed surfaces shall be cleaned, wetted, and filled with patching mortar. The patches shall be finished flush and cured and shall match the texture and color of the adjacent concrete.

3-9.02. Grout Cleaning. Not Used.

3-10. TOLERANCES. Tolerances for cast-in-place concrete work shall be as stipulated in ACI 117, unless otherwise indicated.

3-10.01. Settling Basin Tolerance. Not Used.

3-10.02. Ringwall Tolerances. The top of the foundation ringwall for each steel reservoir shall be accurately constructed within the following tolerances:

a. In any 30 foot [9,000 mm] length, the top of the wall shall not vary from level by more than 1/4 inch [6 mm] peak to valley.

b. No two points on the top of the wall shall differ in elevation by more than 1/2 inch [12.5 mm].

Levels will be checked on the top of the foundation wall, and any variations exceeding the specified tolerances shall be corrected prior to erection of the reservoir.

3-11. CONCRETE WASH WATER TROUGHS. Not Used.

3-12. PAN STAIRS. Not Used.

3-13. COMPOSITE TOPPING CONCRETE. Not Used.

3-14. CLEANING EMBEDMENTS. Embedments shall be clean when installed. After placement of concrete, surfaces of embedments not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

End of Section

Section 03600

GROUTING

PART 1 - GENERAL

1-1. SCOPE. This section covers procurement and installation of grout. Unless otherwise specified, only nonshrink grout shall be furnished.

Epoxy grouting of anchor bolts, threaded rod anchors, and reinforcing bars is covered in the anchorage in concrete and masonry section. Grouting of masonry is covered in the building masonry section.

1-2. SUBMITTALS. A letter of certification indicating the types of grout to be supplied and the intended use of each type shall be submitted in accordance with the Submittals Procedures section.

1-3. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent damage of any kind. Materials shall be protected from moisture.

PART 2 - PRODUCTS

2-1. MATERIALS.

Nonshrink Grout	Precision cementitious grout with demonstrated non-shrinking properties, minimum 28 day compressive strength of 9000 psi; L&M "Crystex", BASF "Masterflow 928", Sika "SikaGrout 328", or Dayton Superior "Sure-Grip High Performance Grout".
Water	Clean and free from deleterious substances.

2-2. CEMENTITIOUS GROUT. Cementitious grout shall be furnished factory premixed so that only water is added at the jobsite.

2-3. EPOXY GROUT. Epoxy grout shall be used in lieu of cementitious grout when required by the equipment manufacturer for performance or warranty requirements.

Epoxy grout products and installation procedures shall be submitted to Engineer for approval.

PART 3 - EXECUTION

3-1. PREPARATION. The concrete foundation to receive nonshrink grout shall be saturated with water for at least 12 hours preceding grouting unless additional time is required by the grout manufacturer.

3-2. INSTALLATION.

3-2.01. Mixing. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.

3-2.02. Placement. Unless otherwise specified or indicated on the Drawings, grout under baseplates shall be 1-1/2 inches [38 mm] thick. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the baseplates are completely filled without voids. Forms shall be provided where structural components of baseplates will not confine the grout.

3-2.03. Edge Finishing. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate.

3-2.04. Curing. Nonshrink grout shall be protected against rapid loss of moisture by covering with wet cloths or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 3 days and then an acceptable membrane curing compound shall be applied.

End of Section

Section 03930

CONCRETE CRACK REPAIR

PART 1 - GENERAL

1-1. SCOPE. This section covers the repair of concrete and shotcrete cracks and joints.

1-1.01. General Crack Repair. General crack repair is applicable only to new construction, and shall include the following:

a. Sealing of all cracks and crack networks that are wider than 10 mils (0.01 inch) as measured at the exposed surface.

b. All necessary repairs to structures that have failed a tightness test, including sealing of construction joints.

All costs for general crack repair shall be included in the Contract Price. General crack repair work is expected to be necessary on the Project due to cracks that commonly develop during concrete construction.

1-1.02. Engineer-Directed Crack Repair. Engineer-directed crack repair is applicable only to new construction, and shall only be performed when instructed by Engineer. The work shall include, but is not limited to, the following:

a. Sealing of construction joints that are not otherwise required to be sealed as the result of a failure of a leakage test.

b. Sealing of cracks and crack networks with a width of 10 mils (0.01 inch) or less as measured at the exposed surface.

Contractor shall include 150 linear feet of Engineer-directed crack repair in the Contract Price. The Engineer-directed crack repair may be either epoxy resin or foam resin, as determined by Engineer.

1-1.03. Pre-Defined Crack Repair. Pre-defined crack repair is applicable only to existing structures, and the extent of this type of repair is indicated on the Drawings.

Prior to beginning the repair work Contractor shall field verify and provide clear bright colored marking to the cracks to be repaired. Crack repair work shall not begin until marking is complete and has been approved by Engineer.

1-2. SUBMITTALS. Specifications and data covering physical properties, mixtures, application procedures, and curing procedures of the materials proposed shall be submitted in accordance with the Submittals Procedures section. Submittals shall include the approvals from the material manufacturer.

1-3. QUALITY ASSURANCE.

1-3.01. Manufacturer's Field Services. The material manufacturer shall provide engineering field services to review the Project and the material application prior to any preparation; to approve the applicator, the material used, and the procedure to be used; to observe surface preparation; to approve surface preparation; and to observe application. The field representative of the material manufacturer shall submit, in writing through Contractor, approvals of proposed material, application procedures, applicator, and surface preparation. The field representative shall be an employee of the material manufacturer.

1-3.02. Applicator. The applicator shall submit through Contractor a satisfactory experience record including references from previous application of the specified materials to structures of similar design and complexity.

1-3.03. Pre-Construction Meeting. At least 30 days prior to concrete crack repairs, Contractor shall conduct a meeting to review the detailed requirements for rehabilitation work. Site conditions, surface preparation, proposed equipment, procedures, material mixing, placing procedures, and curing methods shall be discussed and approved by Engineer and by the manufacturer's field representative. Contractor shall require the attendance of all involved parties, including but not limited to Contractor's superintendent, repair contractor, manufacturer's field representative and proposed equipment supplier representative. Minutes of the meeting shall be recorded, typed and printed by Contractor and distributed to all parties within 5 days after the meeting.

1-3.04. Quality Assurance Certification. Material manufacturers shall be ISO 9001/9002 registered or shall provide proof of documented quality assurance. The documented quality assurance system shall be obtained through an independent auditing registrar.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Unless otherwise specified or authorized, repairs shall conform to the requirements specified herein. Types of repairs

not specified herein shall be as specified in other sections, as indicated on the Drawings, or, in the absence of any definite requirement, as recommended by the manufacturer's representative and subject to acceptance by Engineer. The following types of repairs shall be performed as required.

2-1.01. Pressure-Injected Epoxy Resin. Unless indicated otherwise on the drawings, pressure-injected epoxy resin shall be used to seal joints and cracks that are not intended to permit movement.

2-1.02. Pressure-Injected Foam Resin. Unless indicated otherwise on the drawings, pressure-injected foam resin shall be used to seal joints and cracks that are intended to permit movement.

2-1.03. Crack Sealant. Crack sealant shall be used to seal cracks in structures prior to pressure injection of resin.

2-2. ACCEPTABLE PRODUCTS. Repair products/materials shall be as specified herein. Equivalent products of other manufacturers regularly producing high quality concrete crack repair products/materials, providing engineering field services, and meeting the specified quality assurance requirements may be furnished subject to review and acceptance by Engineer.

2-3. MATERIALS. Materials shall be approved by the manufacturer for the type of application, including temperature and moisture conditions encountered.

Pressure-Injected Epoxy Resin	ASTM C881, Type I or Type IV, moisture tolerant or moisture insensitive.
Pressure-Injected Foam Resin	Hydrophillic polyurethane foam; Prime Resins “Prime-Flex 900 XLV”, DeNeef "HYDRO ACTIVE Sealfoam NF", or Avanti “AV-333 Injectaflex”.
Foam Resin Accelerator	As recommended by foam resin manufacturer.
Crack Sealant	As recommended by the manufacturer of the pressure-injected epoxy resin product.
Water	Clean and free from deleterious substances.

PART 3 - EXECUTION

3-1. INSPECTION. Prior to the placement of the repair materials, the crack to be repaired shall be inspected by the material manufacturer to assure that preparation and conditions are correct for the type of repair and the product/material being used as specified herein.

3-2. PREPARATION. All cracks and surfaces around the cracks shall be free of objectionable substances and shall conform to the requirements of the material manufacturer. Concrete and shotcrete to be repaired shall be cleaned by methods acceptable to the material manufacturer so that the cracks are free of dirt, oil, grease, laitance, and other foreign matter. All loose and deteriorated existing concrete and shotcrete shall be removed down to sound materials. All concrete and shotcrete surfaces shall be checked for delamination to ensure that all surfaces are sound. All edges shall be square cut to avoid feather edges.

Any other preparation recommended by the material manufacturer shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

Concrete and shotcrete surfaces in the area of a crack to be repaired shall be cleaned by wire brushing, blasting, or other acceptable methods.

Wall surfaces shall be sandblasted clean to expose crack networks and construction joints. If there is active water seepage in the repair area, the seepage shall be stopped as recommended by the injection material manufacturer and as acceptable to Engineer. Injection ports shall be installed, when recommended by the injection material manufacturer.

3-2.01. Injected Epoxy Resin. Preparation for injected epoxy resin shall include sealing the surface at the crack, on both sides when possible, with crack sealant as recommended by the material manufacturer and as acceptable to Engineer for the pressure injection work. Injection ports for epoxy resin shall penetrate through the crack sealant into the cracks at spacings recommended by the material manufacturer.

3-2.02. Injected Foam Resin. Preparation for injected foam resin shall include drilling offset injection holes at an angle that will intersect the crack, joint, or crack network at approximately one-half the thickness of the concrete or shotcrete up to a thickness of 36 inches. Spacing of injection ports shall be determined as recommended by the injection material manufacturer and as acceptable to Engineer. When the injection material manufacturer certifies, in writing, that spacing of injection ports and installation procedures are acceptable, the injection ports may be installed directly into the crack, subject to review by Engineer.

3-3. APPLICATION. Concrete and shotcrete repair work shall be performed in accordance with the following requirements.

3-3.01. Crack Sealant. Crack sealant shall be trowel-applied to a minimum dried thickness of 1/8 inch [3 mm]. The concrete surface where the sealant is applied shall be smooth, uniform, and free from irregularities. Crack sealant shall be removed after the injection of resin is completed whenever the sealant will be visible after completion of the work.

3-3.02. Pressure-Injected Resin. The injected areas shall be prepared as specified and as recommended by the manufacturer. Pressure-injected resin shall be suitable for penetration of joints, cracks, and crack networks 2 mils (0.002 inch) wide and larger.

After the joints and cracks are prepared and before the injection of the resin, the joints shall be flushed with water. The water flush shall be terminated when the turbidity of the expelled water is equal to that of the flush water.

The pumping equipment used for the pressure injection of resin shall have pressure metering. Written procedures for use and quality control of the injection equipment shall be furnished to Engineer for review and acceptance. The pump shall be electric. The material and process used for the pressure injection of the resin shall have been in use a minimum of 5 years.

The joints and crack networks shall have a minimum of 90 percent penetration of resin into the joint or crack network. Core samples may be taken at Engineer's discretion.

3-3.02.01. Epoxy Resin. Epoxy resin shall be injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to Engineer. Epoxy resin shall be injected until the resin appears at the next injection port.

3-3.02.02. Foam Resin. Foam resin shall be premixed and injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to Engineer. Foam resin shall be injected into the structure until the resin appears at the next injection port.

Surfaces of cracks and joints may need to be sealed with crack sealant.

3-3.03. Cold Weather. When ambient temperatures below 40°F are expected during the curing period, the repair materials shall be maintained at a temperature of at least 50°F for 14 days or 75°F for 7 days after placement. Sudden cooling of the repair materials shall not be permitted.

3-4. PROTECTION. Post-placement curing and protection shall be as specified herein and in accordance with the manufacturer's recommendations.

3-5. CLEANING. Work areas shall be cleaned each day in accordance with the Project Requirements section. Upon completion of the final cleanup, Contractor shall restore all

areas affected by the grouting procedures to their original condition, leaving no trace of material piles or other wasted materials.

End of Section

SECTION 03990

ELECTRICAL ENCLOSURE

PART 1 - GENERAL

1-1. SCOPE

1-1.01. Two precast concrete buildings shall be provided and erected as specified herein in the location shown on the Drawings. These buildings shall be provided complete with doors, hardware, and all appurtenances as specified herein.

1-1.02. Coordination:
The ICWRC Electrical Enclosure Building and the SRWRC Electrical Enclosure Building shall be erected on a concrete slab as indicated on the Drawings. Each building shall be suitable for housing electrical equipment which shall be installed therein as indicated elsewhere in these documents. The buildings shall be designed, fabricated, erected, and equipped in accordance with all applicable codes, laws and regulations, and as specified herein. Wall openings for HVAC and electrical equipment shall be provided at approximate locations indicated on the drawings. Contractor shall confirm wall opening sizes and locations based on furnished equipment and coordinate these requirements with the building manufacturer prior to submitting shop drawings. To ensure proper coordination, all building appurtenances shall be obtained and provided by the building manufacturer.

1-2. SUBMITTALS

1-2.01. Complete shop drawings and product data shall be submitted in accordance with the General Conditions Section. Shop drawings illustrating the design, fabrication and assembly of the building shall be sealed by an engineer registered in the State of Georgia. Submittals shall include data on concrete mix design, details on the method of attachment between slab and walls, 8 in x 8 in sample of finish, and hardware submitted shall include color chart.

1-3. QUALITY ASSURANCE

1-3.01. The precast concrete building producer shall be a plant-certified member of either the National Precast Concrete Association (NPCA), The Precast/Prestressed Concrete Institute (PCI), or equal.

1-3.02. The precast concrete building producer shall demonstrate product knowledge and must have a minimum of 5 years of experience manufacturing and setting precast concrete.

1-4. PRODUCT DELIVERY. STORAGE AND HANDLING

1-4.01. On delivery to jobsite, place materials in area protected from weather.

1-4.02. Store materials above ground on framework or blocking. Cover wood for forms with protective waterproof covering. Provide for adequate air circulation or ventilation.

1-4.03. Handle materials to prevent damage.

PART 2 - PRODUCTS

2-1. MATERIALS. Materials for the precast concrete members shall be free from defects, and shall meet the following requirements unless indicated otherwise on the design drawings.

Prestressing Strand	ASTM A416.
Reinforcing Steel	ASTM A615, Grade 60, deformed.
Welded Wire Fabric	ASTM A1064.
Deformed Bar Anchors (DBA)	ASTM A1064 with a minimum 70,000 psi yield strength and minimum 80,000 psi tensile strength. TRW/Nelson division or equal.
Headed Studs	ASTM A108 with a minimum 50,000 psi yield strength and minimum 60,000 psi tensile strength. TRW/Nelson division or equal.
Steel Embedments and Accessories	
Shapes and Plates	ASTM A36, galvanized.
Bolts and Nuts	
High Strength	ASTM A325, Type 1; tested in accordance with Article 9.2 thereof.
Unfinished	ASTM A307.
Nuts, Self-Locking	Prevailing torque type; IFI-100, Grade A.
Washers	
Flat	ASTM F844.

Flat, Hardened	ASTM F436, Type 1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Beveled	ASTM F436, Type 1.
Galvanizing	Hot dipped, G90, in accordance with ASTM A123, A153, and A385.
Concrete	Minimum compressive strength of 5,000 psi at 28 days. Minimum precast (not prestressed) release and stripping compressive strength of 3,000 psi. Minimum precast/prestressed release and stripping compressive strength of 3,500 psi.
Cement	ASTM C150, Type I or Type III. One source for duration of pouring of each product type.
Aggregates	Standard weight ASTM C33, or light weight ASTM C330.
Water	Clean and free from deleterious substances.
Bearing Pads	Elastomeric isotropic random oriented fiber reinforced pad; JVI Inc. “Masticord” or Voss Engineering “Fiberlast”
Insulated Panel Accessories	
Extruded Polystyrene (XPS) Rigid Insulation	1.5-inch thickness, Rigid, unfaced, square edged thermal extruded polystyrene insulation formed from polystyrene base resin conforming to ASTM C578, Type IV or X.
Type IV	Nominal density of 1.55 lb/ft^3 with minimum thermal resistance (R-5) per 1.0 inch thickness of 5.0 °F-ft^2-h/Btu at 75 °F
Type X	Nominal density of 1.30 lb/ft^3 with minimum thermal resistance (R-5) per 1.0 inch thickness of 5.0 °F-ft^2-h/Btu at 75 °F

Wythe Connectors	
Nonmetallic	Non-conductive, non-corrosive, thermoplastic resin or fiberglass composite type with maximum thermal conductivity of 2.50 Btu-in/(hr-ft^2 °F) per inch of length.

2-2. PRECAST BUILDING

2-2.01. The enclosure shall be a precast, reinforced concrete structure with walls and roof. The enclosure shall be manufactured with a mechanism for assembly under tension and shall be provided with joints to be caulked with a urethane sealant compound to maintain a permanent seal under severe weather conditions. All joints shall be finished and caulked, and concrete on the interior shall be smoothed to remove any projections.

2-2.02. Concrete shall be 5000 PSI minimum 28-day compressive strength, air-entrained. All inserts shall be bolted directly to form before casting panels. No floating–in of connection inserts shall be allowed.

2-2.03. The Precast Concrete Building section was written around the Easi-Span Buildings system by Easi-Set Industries, Midland, VA; but equal systems will be acceptable from other manufacturers.

2-2.04. The building and products specified herein shall be designed to meet the general, wind, snow, ice, and seismic requirements as indicated in the Meteorological and Seismic Design Criteria Section, as well as all applicable loading criteria defined on the Structural Notes Sheet.

2-2.05. The buildings shall have minimum interior dimensions as follows:

Building	Width	Length	Height
ICWRC Electrical Enclosure	12’-0”	52’-0”	13’-0”
SRWRC Electrical Enclosure	10’-0”	35’-0”	11’-0”

2-2.06. Post tensioning Strands: Roof shall be post-tensioned in field after keyway is filled and cured to required PSI strength. Post-tensioning cables shall be 41K polystrand CP50, ½ inch, 270 KSI, 7-wire strand, enclosed within a greased plastic sheath (ASTM A416).

2-2.07. Finish: The exterior walls shall have an exposed pebble stone concrete pattern with cant strip extension at base and roof line. Exterior color shall match surrounding structures and shall be approved by the Owner. Interior finish shall be smooth form finish, unpainted.

2-2.08. Roof: Roof panel shall have a minimum 2-inch slope from peak to edge. The roof shall extend 3 inches beyond wall panels and include turndown roof with built-in drip edge.

2-3. ALUMINUM DOORS AND FRAMES

2-3.01. Exterior doors shall be provided as indicated on the drawings for each building. The door opening dimension shall allow for a clear opening for equipment, as listed below. All aluminum shall receive an anodic coating to match the surrounding existing buildings (AA-M10C22A44 Medium Bronze or Dark Bronze, field verify).

Building	Door Type	Size
ICWRC Electrical Enclosure	Double Door	6'-0" x 9'-0"
	Single Door	3'-0" x 9'-0"
SRWRC Electrical Enclosure	Double Door	6'-0" x 8'-0"
	Single Door	3'-0" x 8'-0"

2-3.02. Frames. Extrusions shall be minimum 1/8 inch thick, 6063-T5 aluminum alloy. Integral slot in stops shall receive manufacturer's standard replaceable compressible gaskets or pile weather-stripping.

2-3.03. Doors. Doors shall be flush aluminum doors meeting the following criteria:

- Thickness: 1-3/4 inches.
- Perimeter Tube: Minimum 4 inches wide x 1/8 inch thick, 6063-T5 aluminum alloy.
- Face Sheet: Minimum 0.120 inch thick aluminum sheet; alloy and temper as recommended by manufacturer for specified finish.
- Outswinging exterior doors shall be finished flush at the top, with all seams and joints closed watertight.
- Core: Manufacturer's standard moisture-resistant honeycomb or grid core; no wood members permitted.
- Provide weather-stripping, sweep, drip and threshold, on all exterior doors.
- Butts: Four (4) stainless steel hinges per door, ball bearing ANSI A5112, non removable pin.
- Each door leaf in double door assemblies to have a rim exit device and a removable center mullion. Cylinder lock and exterior lever for one leaf only

in each pair.
- Provide stops where door strikes an adjacent wall.

2-3.04. Door Hardware: A complete set of hardware shall be provided and installed on each door in accordance with the following criteria:

- Comply with ANSI A156.1 through A156.18 for materials and fabrication standards, with no "optional" items.

- Install hardware in compliance with manufacturer's instructions. Door and Hardware Institute standards, and accessibility regulations.

- Provide all ancillary components for a complete and functional hardware set.

- Manufacturers: Acceptable manufacturers are as follows:
  Hinges: McKinney, Hager, Stanley.
  Cylinders: To match plant keying system selected by Owner.
  Surface Closures: Yale, Sargent, Corbin Russwin.
  Protective Plates and Trim: Rockwood, McKinney, Ives.
  Stops, Silencers: Rixson, Sargent, Glynn-Johnson.
  Threshold: Pemko, Wooster, American Abrasive, or Stubbs.
  Exit Device and removable mullion: Yale, Sargent, Corbin Russwin.

2-4. HEATING, VENTILATION, AND AIR CONDITIONING

2-4.01. Wall openings for ductwork shall be provided at approximate locations as indicated on the Drawings. Contractor shall confirm wall opening sizes and locations based on equipment furnished and coordinate these requirements with the building manufacturer prior to submitting shop drawings. Wall openings shall be sized to provide a one inch gap around the exterior sheet metal dimension of the ductwork.

2-4.02. The insulation provided with exterior walls and roof shall have an R-value of R-7.6 and R-20, respectively, based on the GA Energy Code for Climate Zone 3A, continuous insulation.

2-4.03. The roof shall be capable of supporting the approximate duct weights as indicated on the Drawings. The walls shall be capable of providing lateral support to the duct risers.

2-4.04. All ductwork penetrations shall be flashed and sealed according to the building manufacturer’s instructions.

PART 3 - EXECUTION

3-1. COORDINATION

Prior to delivery of the building, the base and floor shall be prepared by the Contractor as indicated on the drawings. All conduits shall be installed and extended to a minimum of 12 inches above the finish floor elevation. Dimensions of the prepared base shall extend beyond the outside dimensions of the building slab by a minimum of 1 inch on all sides. Slab shall have 1-inch chamfered edges.

Manufacturer shall erect building at the site. Contractor shall coordinate construction of slab, delivery of building, and erection of building with manufacturer.

3-2. SHOP INSPECTION

The Owner may, at their option, visit the shop to observe/inspect building casting and fabrications. The Contractor shall notify the Owner a minimum of one (1) month in advance of casting. The building manufacturer shall provide convenient access to the location of the work and shall cooperate to facilitate inspections.

3-3. INSTALLATION

3-3.01. General:

1. Building shall be set level. Panels shall be fastened together with ¼ inch thick (minimum) galvanized steel brackets (ASTM A283, Grade C) to meet loading requirements. Panel fasteners shall be ½ inch diameter (minimum), ASTM A307, carbon steel. Wall panels shall be connected to floor slab with stainless steel adhesive anchors with quantity, diameter and embedment depth to meet loading criteria.

2. Panel Joints. All joints between panels shall be caulked on the exterior and interior surface of the joints in accordance with the Joint Sealants Section.

3. Welding. If welded connections are required, welding shall be done by qualified welders possessing valid certificates under the qualification procedures of AWS D1.1. Care shall be exercised to avoid overheating and cracking the concrete adjacent to the anchorage plates. All members damaged during welding shall be removed and replaced by the Installer with new, undamaged members at no additional cost to Owner.

4. Roof Joints. Grout in keyways shall be polymer concrete placed after coating keyway with methyl methacrylate resin and isocyanate resin. Top of keyway to be coated with primer followed by one coat of polymeric joint sealant, followed by a fiberglass resin fabric and a second coat of polymeric joint sealant.

End of Section

Section 04200

UNIT MASONRY

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installing of building masonry. Ceramic tile and masonry water-repellant or stain coatings are covered in other sections.

1-2. GENERAL. Building masonry shall be constructed of units of the types, dimensions, arrangements, and coursing indicated on the Drawings and specified herein, complete with all materials, accessories, and appurtenances indicated and specified.

All work shall be in accordance with ACI 530.1 except as modified herein.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

All masonry units shall be handled in a manner which will prevent soiling, chipping, or damage of any kind. Broken, discolored, chipped, or otherwise damaged facing units will be rejected and shall be replaced with undamaged units.

Masonry units shall be stored on pallets, shall be protected against contamination and staining, and shall be kept covered and dry at all times. Lime and cement shall be stored under cover in a dry place.

Sand shall be stored so that the inclusion of foreign materials is prevented. Whenever sand is piled directly on the ground, the surface beneath the sand shall be smooth, well drained, and free from dust, mud, and debris. The bottom 6 inches of each pile shall not be used in mortar.

Insulation shall be stored under cover in a dry place and shall be protected from the weather at all times.

1-4. SUBMITTALS. Before masonry construction is begun, the following drawings, data, specimens, and samples shall be submitted in accordance with the Submittals Procedures section. Additional data shall be submitted as needed. If the source of a material is changed during the course of the work, the tests and reports required for preliminary review of that material shall be resubmitted.

Recycled Content: Documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.

Regional Materials: Documentation indicating location and distance from project of material manufacturer and point of extraction, harvest or recovery for each regional material and the fraction by weight that is considered regional.

Specimens and color selection kits for all masonry units which will be used in the Work, showing range of colors, textures, finishes, and dimensions.

Samples of all masonry units. At least two samples of each type of unit required shall be submitted.

Color selection sample kits for integral mortar colors.

One sample, at least 6 inches long, of each type of non-masonry joint material required.

Control joint locations in the CMU wall per the drawings.

Shop drawings or manufacturers' literature showing details of anchors, ties, metal and other accessories to be used in masonry construction.

Bar lists and drawings for the fabrication and placement of reinforcement with sufficient elevations and sections to adequately detail and label all reinforcement.

Cold and hot weather construction procedures.

Certificates for the following materials used in masonry construction, indicating compliance with the standards herein.

Masonry units.

Mortar and grout materials, including manufacturer data for any admixture, mortar coloring, or other product added to the grout or mortar.

Reinforcement.

Anchors, ties, fasteners, and metal and other accessories.

For each mortar mix, submit mix designs indicating type and proportions of ingredients in compliance with the proportion specification of ASTM C270.

For each grout mix, submit one of the following:

Mix designs indicating type and proportions of ingredients in compliance with the proportion by volume requirements of ASTM C476.

Mix designs indicating type and proportions of ingredients in compliance with the specified compressive strength method of ASTM C476.

1-5. COLOR SELECTION AND SAMPLE PANELS. Colors of masonry units and colored mortar~~,~~ will be selected from manufacturer's data and samples after the award of the contract.

1-5.01. Masonry Units. Colors for face brick~~,~~ and integral colored masonry units shall be selected from manufacturer's standard and custom color selections. Different colors may be required for each type of masonry unit or for different locations of the same type of masonry unit. Special color patterns shall be as indicated on the Drawings. General color selections shall be made from manufacturer's data. After general color selections are made, sample masonry boards shall be submitted to Engineer for preliminary color selections. These boards shall be of sufficient size to show the proposed shade distribution and shall be submitted in as many different colors, textures, arrangements, and shade combinations as may be required for making a proper selection. The preliminary color and texture selections shall be made prior to submitting the full size units and constructing the sample panels specified herein.

All color, shade, and texture selections shall not be final until the field constructed sample panel has been accepted.

1-5.02. Marble and Granite. Not used.

1-5.03. Limestone. Not used.

1-5.04. Glass Block. Not used.

1-5.05. Mortar Coloring~~.~~—Integral mortar color will be selected from sample kits submitted. After general color selections have been made, mortar samples shall be prepared for color selection. As many samples as are necessary to make a proper selection shall be prepared. Preliminary color selections shall be used in constructing

the sample panels. Mortar colors shall not be final until the sample panels have been accepted.

1-5.06. Sample Panels. Before the installation of any masonry materials, sample panels shall be constructed at the Site incorporating each type of masonry material. Sufficient number of sample panels shall be constructed to show each type of exterior and interior wall configuration and bonding patterns indicated on the Drawings. Unless otherwise indicated or detailed on the Drawings, sample panels shall be 8'-0" high. Sample panels shall show the proposed color range, texture, bonding patterns, mortar joints, mortar color, and workmanship for masonry materials.

Each panel shall be of the thickness indicated on the Drawings for building walls of similar construction. The panels shall be representative of each typical exterior and interior masonry wall construction indicated on the Drawings complete with, as applicable, masonry units, bonding patterns, joint reinforcement, wall ties, wall insulation, vertical steel, a typical bond beam, mortar color, mortar tooling, weeps, and flashings. Each sample panel shall include a typical control joint complete with filler strips and caulking as indicated on the Drawings. The sample panels shall not be incorporated into the work. No masonry work shall progress until the Engineer has accepted the sample panels. The panels shall then become the standard of comparison for all masonry work built of the same materials. The panels shall not be destroyed or moved until all masonry work is completed.
At least one exterior wall panel shall include an exterior corner condition and an intersecting interior wall constructed as detailed on the Drawings.

Sample panels shall include masonry waterproofing or stain.

1-6. BRICK ALLOWANCE. Unless otherwise indicated that the face brick match existing, Contractor's bid shall be based on the assumption that the net cost of the facing brick and that the net cost of special shapes, sizes, curved, or beveled units shall be as specified. The Contract price will be adjusted on the basis of the difference between the assumed and the actual net cost of the selected brick, without overhead or profit.

When specified or indicated on the Drawings that facing brick or split-face CMU shall match existing ~~brick~~, Contractor's bid shall be based on the cost of the brick or masonry product necessary for matching the existing brick or masonry. No adjustment to the contract price will be made.

1-7. COMPRESSIVE STRENGTH DETERMINATION. The compressive strength of masonry shall be determined by the unit strength method specified in ACI 530.1.

The design compressive strength of masonry, f'_m, for this project is ***2000*** psi.

Masonry construction shall not begin until Engineer has reviewed the applicable submittals for strength of masonry units, grout, and mortar.

PART 2 - PRODUCTS

2-1. MATERIALS. All acceptable masonry products are indicated below. Products necessary for the work are as specified or as indicated on the Drawings. Sizes of masonry units are nominal, the actual size being slightly smaller to allow for mortar joints.

Concrete block	ASTM C90, 8 inch x 16 inch face dimensions, sizes with special shapes as indicated on the Drawings; lightweight or standard weight aggregate conforming to ASTM C331 or ASTM C33, respectively.
Regular type	Standard gray color, sizes, special shapes, and face pattern as indicated on the Drawings. StandardLight weight aggregate units.
Split face type	Integral color-units or as indicated on the Drawings with integral moistureproofing admixture; full face, single scored, or multiple scored units with special corner units, bond beam units, and other required special units as indicated on the Drawings.
Sand	Natural sand in accordance with ASTM C144. Gradation shall be adjusted as indicated below.
For Pointing Mortar	Gradation in accordance with ASTM C144 except that 95 percent shall be passing the No. 50 sieve.
Portland Cement	ASTM C150, Type I.
White Cement	Atlas White, Medusa White, or Trinity White.
Hydrated Lime	ASTM C207, Type S.
Quicklime	ASTM C5, pulverized.
Lime Putty	Quicklime, thoroughly slaked and stored for one day; kept moist until used.

Integral Mortar Color	ASTM C979, mineral pigments, natural or synthetic iron oxides, sun fast and water resistant, free of fillers and extenders. Soloman Grind-Chem Service, Inc. "A", "H", or "X" series.
False Joint Mortar	ANSI A118.4, Type S, Portland cement mortar with latex admixture, color to match mortar color.
Integral Waterproofing	Aluminum stearate, ammonium stearate, or calcium stearate, 2 percent of weight of cement; W. R. Grace "Dry Block Mortar Admixture", A. C. Horn "Hydratite", or Sonneborn "Hydrocide".
Grout	ASTM C476, conventional coarse grout.
Portland Cement	ASTM C150, Type I.
Sand	ASTM C404, natural sand.
Pea Gravel	ASTM C404.
Water	Clean and free from deleterious substances.
Prepared Joint Filler	ANSI A118.6 Sanded tile grout. Laticrete Series 500 joint filler, Bonsal "Sanded Grout" or Bostik "Hydroment Joint Filler".
Joint Reinforcement	Dur-O-Wall or Hohmann and Barnard; fabricated from cold drawn steel wire, ASTM A951; stainless steel, ASTM A580 Type 304; type as indicated on the Drawings with prefabricated corners and tees.
Ladder Type	Two-rod and three-rod types as indicated on the Drawings.
Standard Weight	9 gage side rods and cross rods.
Heavy-Duty	3/16 inch side rods and 9 gage truss rods.
Adjustable Type	Ladder type, 9 gage side rods and cross rods with 3/16 inch wire rectangular tabs and pintle ties at 16 inches on center.

Anchors and Ties	
CMU Wall Ends to Concrete	Dovetail anchor system.
Anchors	Corrugated anchor, 12 gage, 1 inch wide, punched or notched or mortar grip; length 16 inches or as indicated on the drawings. AISI Type 304 stainless steel.
Slots	22 gage, AISI Type 304 stainless steel, with fillers.
Reinforcing Steel	ASTM A615, Grade 60, deformed.
Rebar Positioner	9 gage wire, sized for block thickness, single or double bar type, galvanized ASTM A153, Class B-2.
Asphalt Emulsion	Water based asphalt emulsion per block manufacturers recommendation.
Sealant	Nonstaining waterproof silicone type as recommended by block manufacturer.
Backer Rod	Polyethylene foam or neoprene as recommended by block manufacturer.
Structural Wall Preformed Control Joint Material	
Fire Rated Walls	ASTM D2000, extruded rubber, Dur-O-Wall rubber control joint materials or Hohmann & Barnard “#RS Series”
Detergent Masonry Cleaner	ProSoCo "Vana-Trol" or National Chem-Search "DC-6", unless otherwise recommended by the masonry unit manufacturer and accepted by Engineer.

Wall flashings are covered in the Sheet Metal section.

2-2. MORTAR. The use of masonry cement, mortar cement, or premixed ingredients will not be acceptable.

2-2.01. Masonry Mortar. Masonry mortar shall be qualified in accordance with the proportion specifications of ASTM C270.

Integral waterproofing shall be added to each mortar mixture.

2-2.02. Integral Mortar Color. Integral mortar coloring shall be added to the mortar for masonry as specified herein. All other joints shall be standard gray mortar. Each mortar color shall be of consistent color throughout the Project.

2-3. GROUT. Grout shall be proportioned in accordance with ASTM C476, either by volume in accordance with Table 1 or by the specified compressive strength method. Only enough water shall be added to produce a mixture which is flowable, but which will not show an excess of water when placed. Unless otherwise specified, grout shall have a slump ranging from 8 to 11 inches .

PART 3 - EXECUTION

3-1. MORTAR.

3-1.01. Mixing. The method of measurement of all mortar ingredients shall be accurate and shall ensure definite and uniform proportions. All mortar ingredients shall be mixed on site. Mortar shall be machine mixed for at least 5 minutes and shall be used within 90 minutes after mixing. Mortar left when work is stopped shall be discarded. Remixing of mortar more than 90 minutes old with additional water, cement, or other materials will not be acceptable.

The integral mortar color manufacturer's mixing instructions and proportions shall be strictly adhered to. Following the addition of integral mortar color, the mortar shall be mixed in a powered mixer until a uniform color is obtained, but not less than 5 minutes.

3-1.02. Jointing.

3-1.02.01. General. Masonry shall be laid in straight, level, uniform courses, with mortar joints of uniform width. Head joints shall approximately equal the horizontal joints in width.

Joints in masonry surfaces which are to be covered or not exposed shall be struck flush.

All exterior and exposed interior mortar joints, except joints in glazed materials, joints in walls which are to be covered, and joints which are to be raked, shall be tooled to a smooth uniform surface and shall be finished free of voids using a rounded tool. Mortar joints specified to be caulked shall be raked to a depth of 1/2 inch . Tooling of joints shall be regulated so that the mortar for each wall space has a uniform appearance.

The filling of masonry joints shall mean that the entire space between abutting surfaces of units is full, and that the body of the mortar is forced against and into the porous surface of each unit.

3-1.02.02. Brick. Not Used.

3-1.02.03. Concrete Block. Abutting surfaces of head joints shall be completely and solidly cemented together with mortar.

Solid masonry units, starter courses for hollow units with vertical cells, hollow units with horizontal cells, and all units in masonry columns or pilasters shall be laid on a full bed of mortar.

All hollow masonry units with vertical cells (above the starter course) shall be laid with face shell mortar bedding. In partially grouted walls, web joints of all cores which will be subsequently filled with grout fill shall be fully mortared. In fully grouted walls, web joints are not required to be mortared. All collar joints in multiwythe masonry walls, except cavity walls, shall be completely filled.

3-2. BONDING AND REINFORCING.

3-2.01. Bonding. Except where otherwise indicated on the Drawings, all facing brick and concrete block shall be laid in running bond. Special bonding patterns shall be as indicated on the Drawings.

3-2.02. Joint Reinforcing. Joints in horizontal masonry units shall be reinforced as specified, unless otherwise indicated on the Drawings.

The width of joint reinforcement (side rod to side rod) shall be approximately 2 inches less than the nominal overall thickness of the wall in which it is placed. All joint reinforcement shall be fully embedded in mortar and shall be covered with at least 5/8 inch of mortar on the exterior face

Joint reinforcing shall be discontinuous at control and expansion joints. The ends of sections of joint reinforcement shall be lapped at least 8 inches with the next section. At corners and intersections, prefabricated corner and tee reinforcing pieces shall be used.

3-2.02.01. Concrete Block . Mortar joints in concrete block shall be reinforced with continuous ladder type joint reinforcement spaced not more than 16 inches apart vertically. The joint reinforcement shall have one longitudinal rod at each face shell of the masonry units.

Cavity wall mortar joints shall be reinforced by means of continuous standard weight ladder type joint reinforcement spaced at 16 inches vertically. The reinforcement shall bridge the gap between the wythes of masonry.

3-2.03. Masonry Anchorage. Masonry anchorage to an abutting structure or to backup construction shall be as specified herein, unless indicated otherwise on the Drawings.

Tops of masonry walls which abut the underside of steel or concrete beams shall be anchored to the beams as indicated on the Drawings.
Unless indicated on the Drawings to be unconnected, ends of masonry walls which terminate at concrete columns or walls shall be anchored to the concrete by anchor slots cast in the concrete and dovetail anchors built into the masonry. Dovetail anchors shall be spaced 16 inches apart vertically. Dovetail anchors shall also be placed in each bond beam and in the course above and below each bond beam. Vertical cells of hollow masonry at each column or wall anchor shall be filled with grout.

3-2.04. Reinforcing Steel. Concrete block bond beam units shall be installed and reinforced as indicated on the Drawings. Bond beam units shall be filled with grout fill as specified herein. Reinforcing steel shall be continuous around corners. At expansion joints, all bond beam reinforcing shall be discontinuous. At control joints, all bond beam reinforcing shall be continuous through the joint.

Vertically reinforced concrete block cores shall be provided as indicated on the Drawings. Reinforcing shall be accurately placed and securely tied to prevent shifting during core filling. Bar positioners shall be used for alignment. Positioners shall be placed in the bottom and top courses of walls and at not more than 4 feet centers between. Mortar fins which project into cores more than 1/2 inch , and all loose mortar and debris, shall be removed before filling the cores. Cores shall be filled with grout fill as specified herein.

3-2.05. Grout. Unless otherwise acceptable to Engineer, grout shall be placed in lifts not to exceed 5 feet . Lifts exceeding 12 inches in height shall be consolidated by mechanical vibration and reconsolidated after initial water loss and settlement. Bond beam grout shall not be mechanically vibrated. Grout shall be placed in reinforced block cores, bond beams, lintels, and in other locations indicated on the Drawings. If the cells beneath a bond beam are not required to be grouted, wire mesh material may be used in the joint to retain the grout.

3-3. LAYING MASONRY UNITS. All masonry units shall be free from dust, dirt, and surface moisture when laid. Concrete blocks shall be dry when laid.

All masonry shall be laid to a line. Walls shall be plumb and straight and in level courses. At no time shall any part of masonry construction project more than 8 feet above adjacent work. When work is suspended, the tops of exterior masonry walls shall be covered and protected from the weather.

Care shall be taken in corner construction and at jambs to maintain uniformity of appearance and to ensure that only whole, undamaged units are used. All patterned masonry units shall have special corner units installed at exposed corners to maintain consistency of patterns. Masonry units shall be selected and laid so that the exposed face of each unit is free of broken corners, chipped edges, or other defects which would be detrimental to the appearance of the wall surface.

Units laid in stack bond or soldier coursing shall be carefully plumbed, so that vertical joints will form uniform, continuous vertical lines of uniform width, texture, and general appearance. Units shall be of uniform length and shall be trimmed as necessary. Facing brick in stack bond, patterns, or soldier coursing shall be selected to meet the dimensional tolerances and chippage limitations of ASTM C216 for Type FBX brick. Short closure pieces shall not be used in stack bond.

Masonry units laid in running bond shall be so constructed that vertical joints in alternate courses lie in the same vertical lines, midway between the vertical joints in adjacent courses to provide a regular and uniform joint pattern. All custom scored units shall be aligned as detailed on the Drawings.

Masonry units shall be saw-cut to provide openings and to accommodate embedded items. Anchors shall be securely embedded in mortar. Door and window frames shall be maintained plumb and true. Masonry shall be built tightly against interior door frames. A caulking space shall be provided between exterior door frames and masonry in accordance with the details indicated on the Drawings. The jambs of built-in hollow metal door frames shall be completely filled with grout fill.

Lintels shall be provided over all openings wider than the length of a masonry unit. Lintels shall be of the types and sizes indicated on the Drawings, and shall be acceptable to Engineer. Lintels longer than 3 feet shall bear on solid masonry units or on grout-filled cells of hollow units at least one masonry course in height, unless otherwise indicated on the Drawings.

All embedded items shall be set and securely anchored in the masonry work as indicated on the Drawings or as acceptable to Engineer. Joints between masonry and embedded items shall be pointed.

Where indicated on the Drawings, rigid insulation shall be installed in the cavity between brick or other veneer material and concrete block, glazed block or structural glazed tile; and in the air space behind veneer facing cast-in-place concrete. The rigid insulation shall be installed in horizontal blocks sized to fit neatly between joint reinforcement or dovetail anchors, with joints butted as closely as possible. The insulation shall be secured to the face of the cast-in-place concrete or the backup masonry with mastic adhesive applied as recommended by the manufacturer and shall be kept from contact with the facing veneer.

Where indicated on the Drawings, the unfilled cores of concrete block or glazed block walls shall be filled with loose insulation. The insulation shall be poured into the space as the work progresses, with care taken to fill all spaces and voids.

3-4. THROUGH-WALL FLASHINGS. Through wall total flash flashing system shall be installed where and as indicated on the Drawings. Flashings in horizontal joints shall be in the bottom of the joints, and the stainless steel drip shall extend past the face of the wall unless otherwise indicated on the Drawings. Flashings shall drain toward the exterior surface of the wall. Lap joints shall be caulked and termination bars shall be screwed and caulked as per manufacturer's recommendations. The manufacturer's installation instructions shall be followed.

Flashings over lintels and sills shall extend 8 inches past each jamb and shall have end dams. Joints in wall flashings shall overlap and shall be caulked as per manufacturer's recommendations.

3-5. EXPANSION AND CONTROL JOINTS. Expansion and control joints in masonry walls and veneer shall be constructed as indicated on the Drawings. Joint material shall be placed tightly in the wall as construction proceeds.

3-6. ANCHORS, INSERTS, AND OTHER PENETRATIONS. All necessary ties, anchors, bolts, inserts, bucks, flashings, sleeves for piping, conduits of every kind, window and door frames, and other work shall be accurately set and securely held in the masonry work as indicated on the Drawings or in a manner acceptable to Engineer. Sleeves shall be provided where small piping passes through the masonry.

Structural shapes, joists, and decking passing through or over the masonry, but not bearing on the masonry, shall be isolated from the masonry by a minimum of 1 inch on all sides, unless indicated otherwise on the Drawings.

3-7. LOW TEMPERATURES. When the temperature of the surrounding air is below 40°F , the cold weather construction procedures of ACI 530.1 shall be followed except as modified below.

a. In addition to the weather protection specified for ordinary conditions, masonry materials shall also be kept from contact with snow, ice, or dampness of any kind.

b. The temperature of the mixed mortar shall be between 70 and 120°F. Mixing water shall be warm, but not above 165°F . If necessary, sand shall be heated also. Mortar mixing equipment shall be heated before it is used. The use of salt or calcium chloride is not acceptable.

c. Masonry units shall be above freezing when laid. If the outdoor

temperature is below 30°F . units shall be heated to at least 40°F . If the temperature is below 0°F , units shall be heated to at least 60°F . Heating shall be done so that the units are not damaged.

d. Masonry shall be kept warm for at least 72 hours after laying. The air temperature at the masonry surface shall be kept between 45°F and 90°F , using heating methods that will not unduly dry out or otherwise damage the masonry. Masonry surfaces inside enclosures shall not be exposed to carbon dioxide gases emitted from heaters. Heat shall be applied to both sides of the wall, with provisions for proper circulation of air. The masonry shall be suitably housed or covered.

3-8. HIGH TEMPERATURES. When the ambient air temperature exceeds 100°F , or exceeds 90°F with a wind velocity greater than 8 mph , the hot weather construction procedures of ACI 530.1 shall be followed.

3-9. FINISH TUCK POINTING. On completion of the work, all exposed masonry shall be pointed where necessary and all voids and holes in the mortar shall be filled to match adjacent joint surfaces. Defective joints shall be cut out and repointed with mortar. Care shall be taken to produce a uniform overall appearance. Spottiness due to variations in either materials or workmanship will not be acceptable.

3-10. PAVING BRICK. Not used.

3-11. PROTECTION FROM DAMAGE. Masonry and all embedded or built-in items shall be carefully protected from damage. Masonry walls discolored by paint, mortar, or concrete shall be rebuilt with new materials.

Where concrete is placed adjacent to or on top of previously constructed masonry, the masonry shall be adequately protected against damage and against splashing of concrete paste.

3-12. CLEANING. Following finish pointing, all exposed masonry surfaces shall be cleaned to remove all surface stains and smears. If stains and smears cannot be removed by the specified methods, Contractor may propose alternative methods or cleaning products. These alternatives shall be acceptable to Engineer before they are used.

A detergent masonry cleaner shall be used to clean facing brick in accordance with the manufacturer's recommendations.

Mortar smears or droppings on concrete blocks shall be removed with a steel trowel after they have hardened to the extent that removal will not cause additional smearing.

Any remaining mortar shall be removed to the extent possible by rubbing with a small piece of block. All surfaces shall then be thoroughly brushed.

3-13. OWNER'S FIELD CONTROL TESTING. Field control tests will be performed by Engineer or a testing laboratory. Contractor shall provide testing personnel with access to all material stockpiles and shall provide the services of one or more employees as necessary to assist with the collection of samples and construction of prisms. Contractor shall provide material samples in sufficient quantity to conduct the specified tests.

As stipulated in the Quality Control section, tests required during the progress of work will be made at the expense of Owner. The frequency specified for each field control test is approximate and subject to change as determined by Engineer.

3-13.01. Clay Masonry Units. Clay masonry units from worksite stockpiles will be tested once per 5,000 square feet of wall. Sampling and testing will be in accordance with ASTM C67.

3-13.02. Concrete Masonry Units. Concrete masonry units from worksite stockpiles will be tested once per 5,000 square feet of wall. Sampling and testing will be in accordance with ASTM C140.

3-13.03. Grout. Grout will be field sampled during placement and will be tested once per 5,000 square feet of wall. Sampling and testing will be in accordance with ASTM C1019. Compressive strength tests shall be conducted at 28 days after sample collection.

3-13.04. Masonry Prism Tests. If the design compressive strength of masonry, f'_m, is determined prior to construction based on prism testing, then prism testing will be required for field verification in lieu of the preceding individual material tests. Prisms representative of the Project masonry will be constructed on Site using worksite stockpiles, and will be tested in accordance with ASTM C1314.

End of Section

Section 05520

HANDRAILING, GUARDRAILING, AND LADDERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the design, fabrication and installation of handrailing, guardrailing, and ladders fabricated from metal or fiberglass shapes. Ornamental railing systems, metal stairs, concrete and masonry anchorage systems, and structural and miscellaneous metals are covered in other sections.

1-2. GENERAL. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

1-3. SUBMITTALS. Complete data, detailed drawings, and setting or erection drawings covering all materials shall be submitted in accordance with the Submittals Procedures section. Each separate piece shall be marked. Drawings and submittals shall be sealed by a professional engineer registered in the state of Georgia.

6.

Data shall be submitted to certify that all railings and ladders meet all applicable requirements of the codes as specified herein and the Specifications and Drawings. Engineer may request copies of all supporting calculations.

1-3.01. Samples. Samples shall be submitted to indicate finishes. Samples of each type of fitting required to complete the installation shall also be submitted.

1-3.02. Colors. Where color selections are required, color charts shall be submitted showing the full range of available colors. Procedures for selecting colors shall be as indicated in the Submittals Procedures section.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Railing and post components shall be individually wrapped in paper or plastic film sleeves to protect the finish during shipment and installation and shall not be covered with any protective paper or other covering which can adhere to, or damage, the components. Maintain the protective covering on railing and posts until the work is complete.

PART 2 - PRODUCTS

2-1. GENERAL. Railing systems and ladders shall be designed and fabricated by companies normally engaged in the manufacture of such systems. Railing products of like materials shall be from a single supplier and the installed systems shall have a uniform appearance throughout the project. Ladders may be from another supplier. Unless indicated otherwise on the Drawings, ladders in proximity with guardrailing shall be of the same material, style, and finish as the guardrailing.

For metal railing systems, at Contractor's option, handrailing and guardrailing shall be either shop fabricated welded systems or prefabricated nonwelded systems designed for field assembly. Welded railing systems shall be fabricated from pipe and accessories by metal fabricators experienced in designing and fabricating welded railing.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS.

2-2.01. Railing System Design Criteria. All railing systems shall be designed and fabricated in compliance with the most stringent requirements of the applicable local building code, OSHA 29 CFR Part 1926 Subpart R, and all other pertinent OSHA regulations and local safety regulations. Handrails for handicapped accessible areas, if required, shall comply with the requirements of the local building code, ANSI 117.1 Uniform Federal Accessibility Standards, and the accessibility standards of the Americans with Disabilities Act. In case of conflicting requirements the more stringent requirements shall be applicable.

At a minimum, guardrailing and handrailing shall be designed to withstand a uniform load of 50 lbs per foot applied in any direction at the top, and a concentrated load of 200 lbs applied in any direction at any point along the top. The uniform load and the concentrated load need not be assumed to act concurrently. The design load shall be transferred through the entire railing system and its support to the structure.

Intermediate rails, including balusters on picket-type systems, shall be designed to withstand a horizontally applied normal load of 50 lb on an area not to exceed 12 inches by 12 inches including openings and space between rails. The load shall be located so as to produce the maximum effects. Reactions due to this loading are not required to be superimposed with the loads specified for the top rail and handrail in the preceding paragraph.

An allowable stress increase of 1/3 shall not be incorporated into the design of any part of the railing system.

Maximum spacing for railing posts shall be 6 feet .

2-2.02. Steel Rails. Not used.

2-2.03. Aluminum Rails. Handrails and guardrails shall be fabricated from 1-1/2 inch ID aluminum pipe.

2-2.04. Fiberglass Rails. Not used.

2-2.05. Kickplate. Kickplates shall be 4 inches high and shall be fabricated from similar materials as the railing. Kickplates shall clear the walking surface by 1/4 inch .

2-2.06. Fasteners. Unless noted otherwise, all fasteners shall be stainless steel. Where galvanized bolts are indicated on the Drawings or specified, the use of zinc-plated bolts will not be acceptable. Metal railings shall be fastened to fittings with through bolts or flush set screws; glued or pop riveted connections are not permitted. Fastener details shall be indicated on the submittal drawings.

2-2.07. Guarding of Openings. Openings in railing shall be guarded by self-closing gates in accordance with OSHA 1910.23.

2-2.08. Removable Guardrail. Removable guardrail sections shall be designed so that each section has at least two, but not more than three posts.

2-2.09. Expansion Control. Guardrailing in outdoor locations shall have slip joints at least every 60 feet and at all concrete expansion joints to permit expansion and contraction. The gap at each slip joint shall be not less than 1/4 inch .

2-2.10. Mounting to Structure. Handrailing and guardrailing shall be mounted to structures as indicated on the Drawings. If mounting details are not indicated, railing posts shall be surface mounted with base flanges or side mount brackets secured to concrete by stainless steel adhesive anchors. Bolt sizes and pattern shall be as needed for the mounting device.

2-2.11. Ladders. Ladders shall be designed to meet the requirements of OSHA Section 1910.27 and ANSI-A14.3. Ladders with climbing heights greater than 20 feet or where the length of climb is less than 20 feet but the top of the ladder is more than 20 feet above the ground, floor, or roof level, shall be provided with fall prevention devices as indicated on the Drawings. Rest platforms shall be provided to limit straight climbs to maximum 30 feet .

Ladders shall be mounted to structures as indicated on the Drawings. If mounting details are not indicated, bracket connectors shall be stainless steel bolts when attached to structural steel or stainless steel adhesive anchors when attached to concrete or masonry.

Ladders exiting through hatchways shall be furnished with extending ladder safety posts.

2-3. ACCEPTABLE MANUFACTURERS. Metal railing shall be Moultrie “Wesrail”, Universal “Uni-Rail”, Thompson “TUF Rail System”, Julius Blum & Co “Connectorail”, or equal.

Metal ladders shall be Alaco “Series 500”, Thompson “TUFLadder”, or equal.

2-4. MATERIALS.

Aluminum Systems

Pipe	Aluminum ASTM B429, Alloy 6061-T6, Schedule 40 minimum thickness.
Shapes and Plates	Aluminum ASTM B308, Alloy 6061-T6 for Shapes. ASTM B209, Alloy 6061-T6 for Plates.
Fittings, Welded	Angles, offsets, tees, ells, crosses, caps for aluminum, ASTM B429, Alloy 6063-T6, Schedule 40 minimum thickness.
Fittings, Non-welded	Manufacturer's standard component fittings, extruded sections, ASTM B221, Alloy 6063-T5 or T6.
Assembly Bolts, Nuts, Washers, and Fasteners	Stainless steel.

Stainless Steel Systems

Pipe	ASTM A312, Grade TP316L, Schedule 40 minimum thickness.
Plates	ASTM A240, Type 316L.
Fittings, Welded	Angles, offsets, tees, ells, crosses caps for stainless pipes shall be made with formed, stainless steel welding ells and welding connectors.
Non-welded	Manufacturer standard component fittings, stainless steel.
Assembly Bolts, Nuts, Washers, and Fasteners	Stainless steel.

Galvanized Steel Systems

Pipe	ASTM A 500 Grade B, Schedule 40 minimum thickness, galvanized after fabrication.
Plates	ASTM A36. Galvanized.
Fittings, Welded	Angles, offsets, tees, ells, crosses, and caps shall be made with formed, welding ells and welding connectors. Material to match railings. Galvanized.
Fittings, Non-Welded	Manufacturer standard component fittings, material to match railings. Galvanized.
Assembly Bolts, Nuts, Washers, and Fasteners	Stainless steel.

Painted Steel Systems

Pipe	ASTM A 500 Grade B, Schedule 40 minimum thickness, prime painted.
Plates	ASTM A36. Prime painted.
Fittings, Welded	Angles, offsets, tees, ells, crosses, caps shall be made with formed, welding ells and welding connectors, material to matching railings. Prime painted.
Fittings, Non-welded	Manufacturer standard component fittings, materials to match railings. Prime painted.
Assembly Bolts, Nuts, Washers, and Fasteners	Manufacturer's standard.

Fiberglass Systems

Tube	Fiberglass reinforced pultruded square tube with surfacing veil and UV inhibitors in vinyl ester resin, ASTM E-84 flame spread of 25 or less.
Kickplate	Fiberglass reinforced pultruded corrugated plate with surfacing veil and UV inhibitors in vinyl ester resin, ASTM E-84 flame spread of 25 or less.
Hardware	Manufacturer’s standard, AISI Type 316 stainless steel.

UV Protective Coating	Manufacturer’s standard, polyurethane.
Steel Pipe Sleeves	
Outer Sleeves	Black steel pipe, Schedule 40. Hot-dip galvanized after fabrication.
Removable Post Inner Sleeves	PVC tube, Schedule 40.
Plastic Pipe Sleeves	PVC tube, Schedule 40.
Post Setting Cement	Minwax "Super Por-Rok Cement" or BASF Set Products Division "Set 45".
Ladder Fall Prevention Devices	OHSA approved fall prevention device with harness.
Anchor Bolts to Prime Painted Steel	ASTM High Strength bolts, nuts, and washers in accordance with the Structural and Miscellaneous Metals section.
Anchor Bolts to Concrete or Masonry	Stainless steel adhesive anchors in accordance with the Anchorage in Concrete and Masonry section.
Shop Coatings	
Universal Primer	Ameron "Amercoat 385 Epoxy", Carboline "Rustbond", or Tnemec "Series 27 F.C. Typoxy."
Red Oxide Primer	SSPC 15, Type 1, or Fed Spec TT-P-636.
Epoxy Enamel	Gray; Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Asphalt Varnish	Fed Spec TT-C-494.
Anodic Finish	AA-M10C22A41, clear unless otherwise required.
Galvanizing	ASTM A123, A153, A385.

2-5. FABRICATION. Unless otherwise indicated on the Drawings, all railings provided under this section shall be of the same type and design.

2-5.01. Welded Metal Railings. All angles, offsets, or other changes in alignment in welded pipe railings shall be made with railing ells and welded connectors. Welded joints shall be flush type. Railings shall be smooth, with all projecting joints and sharp corners ground smooth. Members shall be neatly coped and continuously welded or

mechanically connected at all junctions. Top rails shall run continuously over posts. All rails and posts shall be in the same plane and shall not be offset. All welding shall be done neatly and substantially by a process (e.g., TIG or MIG) producing a smooth weld. All weld spatter and burrs shall be removed, and all welds shall be thoroughly brushed with a stainless steel power wire brush.

Field joints shall be made with a splice-lock connector which shall provide a firm, permanent connection. The connector shall mechanically draw the railing sections together to form tight, hairline joint.

2-5.02. Fiberglass Railings. Not used.

2-5.03. Guarding of Openings. Openings in railing shall be guarded by self closing gates. Self closing gates shall be fabricated of the same materials with the same finish as the guardrailing. The closure device shall be Manufacturer's standard.

2-5.04. Sleeves. Sleeves for fixed handrail posts shall be fabricated from Schedule 40 PVC pipe or from Schedule 40 black steel pipe hot-dip galvanized after fabrication. Sleeves shall provide at least 1/4 inch clearance all around each post and shall be 5 inches long unless otherwise indicated on the Drawings.

Sleeves for removable posts shall have an outer and inner sleeve. The outer sleeve shall be fabricated from Schedule 40 black steel pipe and shall be hot-dip galvanized after fabrication. The inner sleeve shall be Schedule 40 PVC pipe.

2-5.05. Ladders. Ladders,climbing devices, and rest platforms shall be provided as indicated on the Drawings. Ladder rails intersecting guardrailing shall be configured to provide an aesthetically pleasing transition, although ladder rails need not be physically attached to the guardrailing. There shall be no gaps between ladder rails and adjacent guardrailing that would allow passage of a sphere greater than 4 inches in diameter. Railing gaps at ladders shall be protected by self-closing gates.

All necessary brackets, bolts, and anchors shall be provided for installing the ladders.

2-6. COATING.

2-6.01. Ungalvanized Steel. Not used.

2-6.02. Aluminum. All surfaces of aluminum which will be in contact with concrete shall be coated with epoxy enamel. All surfaces of aluminum which will be in contact with dissimilar metals shall have a 15 mil thick sheet of oriented polyester film placed between the two surfaces.

All aluminum railings shall be provided with a clear anodic finish.

2-6.03. Stainless Steel. Unless otherwise specified or permitted, all items fabricated from stainless steel shall be thoroughly cleaned and degreased after fabrication. Pickling or light blast cleaning shall be used to produce a modest etch and shall remove all embedded iron and heat tint. Surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron and shall be repickled as needed to remove all traces of iron contamination. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

2-6.04. Fiberglass. Not used.

2-6.05. Other Surfaces. Shop coating of galvanized steel or stainless steel surfaces will not be required.

PART 3 - EXECUTION

3-1. INSTALLATION. When railings and ladders are assembled, all posts shall be plumb and longitudinal members shall be parallel with each other and with the floor surface or slope of stairs. In any section or run of railing, the center lines of all members shall be in true alignment, positioned in the same vertical plane. All posts in fixed handrail sections and all ladders shall be rigidly attached to the supporting structure. After installation, railings and ladders shall be checked for final alignment, using a tightly drawn wire for reference. The maximum misalignment tolerance for railings shall be 1/8 inch in 12 feet . Bent, deformed, or otherwise damaged installations shall be replaced.

3-1.01. Attachment to Concrete. Posts shall be attached to concrete structures as indicated on the Drawings. Base flanges and side-mount brackets shall be installed with minimal disturbance to the reinforcing steel. Bolts shall be stainless steel adhesive anchors as specified in the Anchorage in Concrete and Masonry section.
Sleeves shall be rigidly supported in accurate alignment in the forms and shall be positioned vertically so that the top of each sleeve is approximately 1/2 inch below the finished concrete surface. The position of all sleeves shall be carefully measured before railings are fabricated. When the railing is set, the posts shall be wedged in accurate alignment, and the annular space between the posts and sleeves shall be filled with post setting cement to the top of the steel sleeve. Filling of the remaining space with sealant, as indicated on the Drawings, is covered in the Caulking section.

3-1.02. Attachment to Steel or Aluminum. Attachments to steel or aluminum shapes shall be made with flanges or with other special attachments or anchorages as detailed on the Drawings.

3-1.03. Removable Attachments. For removable guardrail sections in embedded sleeves, inner sleeves shall be set in outer sleeves in the same manner as specified herein for the setting of fixed posts. Particular care shall be taken to ensure that the

inner sleeves are accurately spaced and plumbed, so that the handrail sections, when set in position, will stand in proper alignment and will be removable without binding.

Removable guardrail sections with base flanges or side mount brackets shall be secured in the bases with removable screws.

3-1.04. Wall Mounted Handrailing. Suitable wall brackets shall be provided where shown or required. Wall brackets shall be securely anchored to walls with stainless steel adhesive anchors as specified in the Anchorage in Concrete and Masonry section. Expansion anchors shall not be used unless specifically indicated on the Drawings.

3-1.05. Connections. Welding connectors and splice locks shall be installed in accordance with the manufacturer's recommendations. Other methods of making connections and changes in alignment will be considered, provided complete information covering the proposed method is submitted to Engineer for review.

End of Section

Section 05530

GRATING

PART 1 - GENERAL

1-1. SCOPE. This section covers the fabrication and installation of metal and fiberglass grating.

1-2. GENERAL. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

1-3. SUBMITTALS. Detailed fabrication and erection drawings covering the grating shall be submitted in accordance with the Submittals Procedures sections. Drawings shall indicate locations of grating supports, profiles, thicknesses, lengths, markings of panels, and fastening methods.

1-4. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damage of any kind. Damaged materials shall be promptly replaced. Materials shall be stored off the ground.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS.

2-1.01. Design Criteria. Except as modified herein, the manufacture and fabrication of metal grating shall comply with recommendations in the "Metal Bar Grating Manual" of the National Association of Architectural Metal Manufacturers (NAAMM). Grating depth shall be as indicated on the Drawings.

Fiberglass grating shall be designed and fabricated to support 100 psf live load with a maximum deflection not greater than L/150 or 1/4 inch , unless indicated otherwise on the Drawings.

2-1.02. Carbon Steel Grating. Not Used.

2-1.03. Stainless Steel Grating. Not Used.

2-1.04. Aluminum Grating. Aluminum grating shall be the pressure locked type, with cross bars deformed or swaged to prevent turning. Bearing bars shall be at least

3/16 inch thick flat stock or equivalent I-bars, with center-to-center spacing of 1-3/16 inches . Cross bar center-to-center spacing shall be 4 inches maximum. Grating shall be a mill finish. Aluminum grating shall incorporate a striated antiskid walking surface produced during the extrusion process

2-1.05. Fiberglass Grating. Fiberglass grating shall be pultruded type with 6 inch cross bar spacing unless indicated on the Drawings to be molded type. All pultruded grating shall have a surfacing veil and UV inhibitors in the resin. Molded grating shall have a square mesh pattern. Walking surfaces of pultruded grating shall have a grit finish. Walking surfaces of molded grating shall be concave or have a grit finish.

2-2. MATERIALS.

Carbon Steel Grating	Not Used.
Galvanizing	Not Used.
Stainless Steel Grating	Not Used.
Aluminum Grating	NAAMM MBG 531, ASTM B221, 6063-T6 or 6061-T6 alloy, pressure or swage locked, mill finish
Fiberglass Grating	ASTM E-84, D635
Molded Type	Isophthalic polyester resin, ASTM E-84 flame spread of 25 or less; IKG Industries "Corgrate Molded SM", Fibergrate Composite Structures molded grating, Strongwell "Duragrate", Seasafe "Gator-Grate".
Pultruded Type	Vinyl ester resin, ASTM E-84 flame spread of 25 or less; IKG Borden "Corgrate FI" (flush top), Fibergrate Composite Structures "Safe-T-Span", Strongwell "Duradek/Duragrid", Seasafe "Gator-Deck".
Grating Stair Treads	Grating stair treads shall match the material and finish of grating in adjacent platforms and floors. Treads shall have a permanently attached or integral non-skid nosing.
Grating Fasteners	Manufacturer’s standard, AISI Type 316 stainless steel.

Clips, Bolts, Nuts, Washers	Manufacturer's standard, AISI Type 316 stainless steel.
Welded Threaded Steel Studs	ASTM A108 fully threaded studs automatically welded with compatible nuts and washers; TRW Nelson Type CFL or acceptable equal.
Stepped Locking Fasteners	Non-penetrating, non-welded mechanical fasteners, with stainless steel clips and bolts, galvanized cast iron body; Lindapter "Grate-Fast" or Grating Specialty Co. "G-Clip".
Fiberglass Grating Support Legs	Adjustable fiberglass legs specifically designed to support elevated molded fiberglass grating; Fibergrate Corporation "Grating Legs" or Strongwall Corporation "Elevated Floor System".
Fiberglass Curb Angle	Vinyl ester resin, fiberglass trim angle with integral concrete anchorage; Fibergrate Composite Structures "EZ angle" or Strongwell Corporation "Fiberglass Curb Angle".

2-3. FABRICATION. Grating shall be fabricated in panels that can be easily handled by plant personnel. Unless otherwise indicated on the Drawings, the weight of individual panels shall not exceed 150 lbs . Panels shall be within ±1/4 inch of authorized length and ±1/4 inch of authorized width, and shall have a maximum difference in length of opposite diagonals of 1/4 inch . The spacing of bearing bars shall be within 1/32 inch of authorized spacing. Cross bars and edge bars of adjacent panels shall align. After installation, there shall be not more than 1/4 inch clearance between panels. All bearing bars shall be parallel. Bands and toeplates shall align within 1/8 inch tolerance, vertical and horizontal.

Angular, circular, and re-entrant cuts in steel grating may be made by flame cutting. All other cuts in steel grating shall be sawed or sheared. Cuts shall be clean and smooth, without fins, beads, or other projections. Any damaged protective coating shall be fully restored.

All cuts in aluminum grating shall be sawed or sheared. All cuts in fiberglass grating shall be cut. All fiberglass grating which requires cutting shall have the affected surfaces sealed with catalyzed resin sealant of equal or superior corrosion resistance to the grating.

Grating panels shall be arranged so that openings are centered on a joint between panels. Toeplates extending the full depth of the grating and 4 inches above the top shall be provided around openings. Toeplates shall be welded to each bearing bar. The ends of bearing bars need not be banded unless required by the Drawings. Bands shall be welded to the first, the last, and every fourth intermediate bar. Bands and toeplates shall be 3/16 inch thick. Crossbars shall be cut off flush with the outside face of side bars.

Steel frames anchored to or cast in concrete to support grating shall be stainless steel or hot-dip galvanized after fabrication. The anchorage of fiberglass curb angles shall consist of intermittent embedded shapes or interlocking deformations on the back side of the angle.

Section Length shall be sufficient to prevent grating from falling down through clear opening when oriented in the span direction when one end is touching either the concrete or the vertical leg of grating support.

2-4. SHOP COATING. Finish painting of grating, if required, is covered in the protective coatings section.

2-4.01. Galvanizing. Not Used.

2-4.02. Aluminum. All surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a coat of epoxy enamel on the contact surfaces.

2-4.03. Fiberglass. All cut edges of fiberglass grating shall be sealed with catalyzed resin sealant of equal or superior corrosion resistance to the grating or as specified by the manufacturer. Sufficient quantities of edge repair coating shall be supplied with the grating.

PART 3 - EXECUTION

3-1. GENERAL. All grating shall lie flat, with no tendency to rock when installed. Grating sections and supports shall be installed to have a solid bearing on both ends, and that rock and wobble grating movement does not occur under designed traffic loading. Poorly fitting or damaged grating shall be rejected. Grating openings may be field cut with the approval of Engineer, provided that no more than four adjacent bearing bars are cut. If the grating is cut or modified in the field, affected surfaces shall be repaired or sealed to assure restoration of the corrosion resistance of the grating. Field cut openings must be spaced so that there are at least as many continuous bars between each opening as there are cut bars at the opening.

3-2. ATTACHMENTS TO SUPPORTING STRUCTURE. All grating supported on steel, aluminum, or fiberglass structures shall be attached. Grating shall be attached to the supporting structure in accordance with the grating manufacturer's recommendations and submittals. Single span grating over flumes, manholes, pits, or other openings in concrete floors may rest unattached in recesses constructed for that purpose. To preclude excessive accumulation of tolerances, an extra-long panel shall be provided for each unanchored grating cover that exceeds 20 feet in length. The panel shall be cut to the required dimension after the remainder of the grating panels have been installed.

3-2.01. Prime Painted Steel Supports. Unless otherwise required or indicated on the Drawings, clip or flange block fasteners or stepped locking fasteners shall be used to attach grating to prime painted steel supports. Clip fasteners shall be secured to the supporting steel with through bolts in drilled holes. Through bolts shall be stainless steel. Fusion welded threaded studs may be utilized if the primer is removed before welding or if a suitable weldable primer is used. Welded studs shall be cleaned and prime painted to match the support steel prior to finish painting.

3-2.02. Galvanized Steel Supports. Unless otherwise indicated on the Drawings, stepped locking fasteners shall be used to attach grating to galvanized steel supports. The galvanized coating shall not be damaged.

3-2.03. Stainless Steel, Aluminum, and Fiberglass Supports. Unless indicated otherwise on the Drawings, clip or flange block fasteners or stepped locking fasteners shall be used to attach grating to stainless steel, aluminum, or fiberglass supports. Fasteners shall be secured to the supporting structure with stainless steel through bolts in drilled holes. Welded fasteners shall not be used.

3-3. FINISH TOUCHUP. After erection, all grating shall be cleaned. Damaged coatings shall be touched up in accordance with the grating manufacturer's recommendations to fully restore the corrosion resistance of the grating. Cut ends of fiberglass grating pieces shall be sealed with catalyzed resin sealant of equal or superior corrosion resistance to the grating itself or repaired in accordance with the manufacturer's recommendations to assure full undamaged performance.

End of Section

Section 05550

ANCHORAGE IN CONCRETE AND MASONRY

PART 1 - GENERAL

1-1. SCOPE. This section covers the design and installation of anchors in concrete and masonry. It includes cast-in-place anchor bolts and anchor rods, adhesive anchors for both threaded rods and reinforcing bars, expansion anchors, and undercut anchors. Where this section and Section 01600 conflict, Section 01600 will take priority.

1-2. GENERAL.

1-2.01. Anchors Designed by Engineer. Cast-in-place and post-installed anchors that are fully detailed on the Drawings have been designed by Engineer, and may not be changed to a different type without written approval of Engineer.

1-2.02. Anchors Designed by Contractor's Suppliers. Contractor's material suppliers shall be responsible for design of anchors for railings, ladders, equipment, pre-engineered structures, and other manufactured items, as indicated in the Drawings and Specifications. Anchors shall be designed for all operating conditions, including wind and seismic loadings when indicated in the Meteorological and Seismic Design Criteria section. Cast-in-place anchors shall be used unless post-installed types are indicated on the Drawings or accepted by Engineer. Adhesive anchors used in vibrating applications, such as for pumps, shall only be used if the manufacturer submits documentation indicating that the product is suitable for the service conditions.

1-2.03. Materials. Unless otherwise indicated, anchors of structural steel members connected to concrete shall have a diameter of at least 3/4 inch, and structural members connected to masonry shall have a diameter of at least 5/8 inch. Anchors for ladders and equipment shall have a diameter of at least 1/2 inch. Anchors for pedestrian railing systems shall have a diameter of at least 3/8 inch.

Unless otherwise indicated on the Drawings, anchors used in the following locations and applications shall be of the indicated materials.

Cast-In-Place Anchor Bolts and Anchor Rods

Submerged locations	Stainless steel.

Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Galvanized steel.
Other exterior locations	Galvanized steel.
Other interior locations	Carbon steel.

Adhesive, Expansion, and Undercut Anchors

Submerged locations	Stainless steel.
Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Stainless steel.
Other exterior locations	Stainless steel.
Other interior locations	Carbon steel.

Adhesive, expansion, and undercut anchors may be used instead of cast-in-place anchors only where specifically indicated or permitted on the Drawings or with the specific acceptance by Engineer.

Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

1-3. SUBMITTALS. Data, catalog cuts, and manufacturer's research reports (from independent organizations such as ICC-ES or IAPMO UES) indicating the manufacturer and types of adhesive anchors, expansion anchors, and undercut anchors to be supplied shall be submitted in accordance with the Submittals Procedures section.

If Contractor requests use of products other than those indicated herein, calculations may be required as part of the submittal package. Calculations shall be prepared by a professional engineer licensed in the state of the project, using methods and procedures required by the building code. Contractor shall demonstrate that the proposed substitute anchors are equivalent in all necessary criteria, including strength, spacing and edge distance limitations, embedment

depth limitations, temperature limitations, and any other criteria required by Engineer.

1-4. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent damage or corrosion. Damaged materials shall be promptly replaced. Materials shall be shipped and stored in original manufacturer's packaging.

PART 2 - PRODUCTS

2-1. MATERIALS. Unless otherwise indicated on the drawings, materials shall be as indicated below.

Cast-In-Place Anchor Bolts and Anchor Rods

Carbon steel	ASTM F1554, Grade 36 with compatible nuts.
Galvanized steel	ASTM F1554, Grade 36 with compatible nuts; hot-dip galvanized, ASTM F2329.
Stainless steel	Bolts, ASTM F593, Alloy Group 1 or 2 (minimum yield strength of 45 ksi); nuts, ASTM F594, Alloy Group 1 or 2.
Flat Washers	ANSI B18.22.1; of the same material as anchor bolts and nuts.

Expansion Anchors in Concrete	Products shall be single component anchors tested in accordance with ICC AC193, and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces. Hilti "Kwik-Bolt TZ" or Powers Fasteners "Power-Stud+SD2" (carbon steel), "Power-Stud+SD4" (304 stainless steel), and "Power-Stud+SD6" (316 stainless steel).
Expansion Anchors in Grouted Concrete Masonry Units	Products shall be single component anchors tested in accordance with ICC AC01, and shall have a manufacturer's research report in compliance with the applicable building code. Hilti "Kwik-Bolt TZ Masonry Anchors", Simpson "Wedge-All", or Powers Fasteners "Power-Stud+ SD1".
Undercut Anchors in Concrete	Products shall be tested in accordance with ICC AC193, and shall have a manufacturer's research report in compliance with the applicable building code. Hilti "HDA Undercut Anchor" (carbon steel) and "HDA-R Undercut Anchor" (stainless steel), or Powers Fasteners "Atomic+ Undercut Anchor" (A36 carbon steel).
Adhesive Anchors in Concrete	Products shall be tested in accordance with ICC AC308, and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.

Threaded Rods and Nuts (Carbon Steel)	ASTM F593, CW.
Reinforcing Bars	ASTM A615, Grade 60, deformed.
Reinforcing Bars, weldable	ASTM A706, Grade 60, deformed.
Adhesive	Hilti “HIT-HY 200", or Powers Fasteners “Pure 110+”.
Adhesive Anchors in Grouted Concrete Masonry Units	Products shall be tested in accordance with ICC AC58, and shall have a manufacturer’s research report in compliance with the applicable building code.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593 CW (Hilti or Powers systems), or ASTM A193 Grades B6, B8, or B8M (for Simpson system).
Adhesive	Hilti "HIT HY 70", Powers “AC100+ Gold”, or Simpson “SET XP”.
Adhesive Anchors in Hollow Concrete Masonry Units	Products shall be tested in accordance with ICC AC58, and shall have a manufacturer’s research report in compliance with the applicable building code.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593 CW (Hilti or Powers systems), or ASTM A193 Grades B6, B8, or B8M (for Simpson system).
Adhesive	Hilti “HIT HY 70”, Powers “AC100+ Gold”, or Simpson “SET XP”.
Screen Tubes	As recommended by the manufacturer.

Adhesive Anchors in Unreinforced Brick Masonry	Products shall be tested in accordance with ICC AC60, and shall have a manufacturer's research report in compliance with the applicable building code.
Threaded Rods and Nuts	ASTM A307.
Adhesive	Hilti "HIT HY 70", Simpson "SET".
Screen Tubes	As recommended by the manufacturer.

2-2. ANCHORS.

2-2.01. Cast-in-Place Anchor Bolts and Anchor Rods. Cast-in-place anchor bolts and anchor rods shall have forged heads or embedded nuts and washers. Anchors shall be delivered in time to permit setting prior to the placing of structural concrete or masonry grout. Anchor sleeves shall not be used unless acceptable to Engineer. Unless installed in sleeves, anchor bolts and anchor rods shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or the supporting template. Two nuts, a jam nut, and a washer shall be furnished for cast-in-place anchor bolts and anchor rods indicated on the Drawings to have locknuts; two nuts and a washer shall be furnished for cast-in-place anchor bolts and anchor rods without locknuts.

2-2.02. Adhesive, Expansion, and Undercut Anchors. When adhesive, expansion, or undercut anchors are indicated on the Drawings, only acceptable systems shall be used. Acceptable systems shall include only those systems and products specified or specifically indicated by product name on the Drawings. Alternative anchoring systems may be used only when specifically accepted by Engineer.

Unless otherwise noted, single nuts and washers shall be provided with adhesive anchors, expansion anchors, and undercut anchors. Adhesive anchors shall be free of coatings that would weaken the bond with the adhesive.

Adhesive anchors in hollow CMU masonry and unreinforced brick masonry shall utilize screen tubes as recommended by the manufacturer.

PART 3 - EXECUTION

3-1. GENERAL. Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchors immediately before tightening of the nuts.

Dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.

If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.

Bent Bar Dowels: Where edge distances are critical, and striking reinforcing steel is likely, drill hole at 10 degree angle or less and use prebent reinforcing bars.

Do not install prior to receiving manufacturer onsite training.

3-1.01. Compliance with Manufacturer's Instructions. Post-installed anchors shall be installed in accordance with the manufacturer's printed installation instructions and all applicable requirements of the manufacturer's research report for the specific anchor system. If conflicts are found between the Drawings, the manufacturer's printed installation instructions, and the manufacturer's research report installation requirements, Contractor shall notify Engineer for resolution.

3-1.02. Special Inspection. Special inspection requirements for cast-in-place and post-installed anchors shall be as indicated in the Code-Required Special Inspections and Procedures section. Anchorage work shall be performed in a manner that allows the inspections to take place without adversely impacting the schedule.

3-2. CAST-IN-PLACE ANCHOR BOLTS AND ANCHOR RODS. Cast-in-place anchor bolts and anchor rods shall be carefully positioned with templates and secured in the forms prior to placing concrete, or in masonry bond beams prior to placing grout. Contractor shall verify that anchorage devices are positioned in accordance with the Drawings and with applicable equipment or structure submittal drawings.

Threads, bolts, and nuts spattered with concrete or masonry grout during placement shall be cleaned prior to final installation of the bolts and nuts.

Sleeves shall be filled with non-shrink grout.

3-3. ADHESIVE ANCHORS. Adhesive shall be statically mixed in the field during application. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.

Anchors or bars shall be installed in holes hammer drilled into hardened concrete or masonry. Drill shall be set to rotation-only mode when drilling into hollow CMU or into brick. Diameter of holes shall be 1/16 inch larger than the outside diameter of the rod or bar unless recommended otherwise by the anchor system manufacturer. Holes shall be prepared by removing all dust and debris using procedures recommended by the adhesive manufacturer.

Adhesive anchors and holes shall be clean, dry, and free of grease and other foreign matter at the time of installation. The adhesive shall be placed and the rods or bars shall be set in accordance with the recommendations of the manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with adhesive, without voids.

3-3.01. Concrete Installation. Unless indicated otherwise on the Drawings, reinforcing bars shall be embedded to a depth of 15 bar diameters, and threaded rods shall be embedded to a depth that will develop the yield strength of the rod.

Adhesive anchors in concrete shall be installed under the following conditions.

Minimum Age of Concrete Prior to Anchor Installation	21 days.
Concrete Temperature Range	Maximum short-term temperature 162 F, maximum long-term temperature 110 F.
Moisture Condition	Dry concrete.
Type of Lightweight Concrete	N/A
Hole Drilling and Preparation	Hammer drill only.

Installation of adhesive anchors into concrete that are either horizontal or upwardly inclined shall be performed only by personnel certified by the ACI/CRSI Adhesive Anchor Installation Certification Program.

3-3.02. Masonry Installation. Anchors shall be installed to meet all criteria in the manufacturer’s installation instructions and ICC-ES reports, including but not limited to minimum compressive strength at time of installation, minimum edge

distances, minimum clearances from mortar joints, minimum anchor spacing, and use of screen tubes.

3-4. EXPANSION AND UNDERCUT ANCHORS. Expansion and undercut anchors shall be installed using all procedures and accessory devices recommended by the anchor manufacturer.

End of Section

Section 05990

STRUCTURAL AND MISCELLANEOUS METALS

PART 1 - GENERAL

1-1. SCOPE. This section covers the fabrication and erection of structural and miscellaneous metal items not covered in other sections, including stainless steel weirs.

Except as otherwise specified or indicated on the Drawings, all work shall conform to the applicable provisions of the AISC "Steel Construction Manual" (14th edition) with the exception of the "Code of Standard Practice for Steel Buildings and Bridges"; and the Aluminum Association "Specification for Aluminum Structures".

Special inspection during the fabrication and erection of structural steel, if required by the local building code, is addressed in the quality control section.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

1-2. SUBMITTALS. Complete data, fabrication drawings, and setting or erection drawings covering all structural and miscellaneous metal items shall be submitted in accordance with the Submittals Procedures section.

All bolted connections and welds shall be properly identified on the shop drawings. Welding procedures, welding procedure qualification records and welder qualifications shall be submitted.

Submittals for high strength bolts, tension control bolts and load indicator washers shall include statements from the bolt and washer manufacturers certifying satisfactory compliance with the governing standards and the specified tests.

1-3. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Structural and miscellaneous metal work shall be stored on blocking so that no metal touches the ground and water cannot collect thereon. The material shall be protected against bending under its own weight or superimposed loads.

Bolting materials shall be stored indoors. Weld rod shall be stored in accordance with the supplier's instructions and AWS D1.1.

1-4. FABRICATOR QUALIFICATION. All fabricating plants providing structural steel shall be qualified fabricators who participate in the AISC Certification program and are designated an AISC Certified Plant, Category STD.

Plant certification is not required for fabrication of miscellaneous metal which does not meet the AISC definition for structural steel found in the AISC "Steel Construction Manual" (14th edition), Part 16.

PART 2 - PRODUCTS

2-1. GENERAL. All structural steel shall be detailed and fabricated to facilitate compliance with OSHA 29 CFR Part 1926 subpart R and all other pertinent OSHA and local safety regulations.

All field connection materials shall be furnished.

2-2. MATERIALS.

Steel

Shapes (W, WT)	ASTM A992.
Shapes (S, M, HP, C)	ASTM A36 or ASTM A572 Grade 50.
Other Shapes (angles)	ASTM A36.
Plates and Bars	ASTM A36.
Sheets	ASTM A1008 CS Type B or A1011 CS Type B.
Pipe	ASTM A53, Type E or S, Grade B (F_y = 35 ksi).
Round Structural Tubing	ASTM A500, Grade B (F_y = 42 ksi).
Square and Rectangular Structural Tubing	ASTM A500, Grade B (F_y = 46 ksi).

Checkered Plate	ASTM A786, carbon steel, skid resistant pattern as standard with the manufacturer; Inland “4-way Floor Plate” or U.S. Steel “Multigrip Floor Plate”.
Bolts and Nuts	
Bolts, High Strength	ASTM F3125, Grade A325, Type 1;
Bolts, Tension Control Type (Twist off)	ASTM F3125, Grade F1852.
Bolts, unfinished	ASTM A307.
Nuts, Heavy-Hex	ASTM A563, grade and finish compatible with bolts.
Nuts, Self-Locking	Prevailing torque type; IFI-100, Grade A.
Washers	
Flat, Hardened	ASTM F436, Type 1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Beveled	ASTM F436.
Load Indicator	ASTM F959, compressible-washer-type direct tension indicator; type compatible with bolts tested in accordance with Article 10.2 of ASTM F959.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A36. Threaded rods shall have sufficient threading to permit the maximum adjustment available. Continuously threaded rod is not acceptable for rods over 12 inches in length.
Forged Steel Clevises and Turnbuckles	AISI C-1035.

Forged Steel Eyebolts and Eyenuts	AISI C-1030, ANSI B 18.15 Type 2 shoulder pattern unless otherwise required.
Forged Steel Sleeve Nuts	AISI C-1018, Grade 2.
Stainless Steel	
Shapes	ASTM A1069 or A276, Type 316L.
Plates	ASTM A240, Type 316L.
Pipe	ASTM A312, Grade TP316L.
Tube	ASTM A269, Grade TP316L.
Checkered Plate	ASTM A793, Type 316L, raised pattern A.
Bolts	ASTM F593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Nuts	ASTM F594, Alloy Group shall match that of the bolts. Nuts shall have a minimum proof stress equal to or greater than the minimum full-size tensile strength of the bolts.
Washers	
Flat	ANSI/ASME B18.22.1, Type 316.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 316.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Cast Iron	ASTM A48, Class 35B or better.
Aluminum	
Sheet and Plate	ASTM B209, Alloy 6061-T6.

Rolled Sections	ASTM B308, Alloy 6061-T6. All members shall be Aluminum Association standard shapes.
Rod and Bar (Rolled or Drawn)	ASTM B211, Alloy 6061-T6 or 2017-T4.
Extrusions	ASTM B221, Alloy 6063-T5 or T6.
Pipe	ASTM B429, Alloy 6061-T6.
Rivets	ASTM B316, Alloy 6061-T6.
Bolts, Aluminum	ASTM F468, Alloy 2024-T4.
Nuts, Aluminum	ASTM F467, Alloy 6061-T6.
Washers, Aluminum	
Flat	ANSI/ASME B18.22.1, Type 6061 T-6.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 6061-T6.
Castings	ASTM B26 or B85.
Checkered Plate	ASTM B632, Type 6061-T6.
Brass or Bronze	
Plate and Strip	ASTM B36.
Casting	ASTM B61 or B584.
Bolts and Nuts	IFI-104, Grade 462 or 464.
Washers	
Flat	ANSI/ASME B18.22.1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Silicon Bronze	

Sheet and Plate	ASTM B96, American Brass "Everdur 1010".
Castings	ASTM B584, American Brass "Everdur 1000".
Bolts and Nuts	IFI-104, Grade 655.
Washers	
Flat	ANSI B18.22.1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Weld Metal (Steel Connections)	ANSI/AWS D1.1, Table 3.1, filler metal with minimum 70 ksi tensile strength unless otherwise required.
Welded Headed Studs, Concrete Anchors, and Shear Connectors	ASTM A108 with a minimum 50,000 psi yield strength and minimum 60,000 psi tensile strength. TRW/Nelson or equal.
Deformed Bar Anchors (DBA)	ASTM A496 with a minimum 70,000 psi yield strength and minimum 80,000 psi tensile strength. TRW/Nelson division or equal.
Rails	
Crane	ASTM A1.
Railroad	ASTM A1.
Bird Screen	2 mesh , brass or copper wire cloth, min wire dia 0.063 inch .
Body Solder	Flux-core wire, ASTM B32, Alloy Grade 20B.
Shop Coatings	
Universal Primer	As indicated in protective coatings section.

Epoxy Enamel	As indicated in protective coatings section.
Galvanizing	ASTM A123, A153, A385, and F2329 as applicable.

2-3. FABRICATIONS. The following fabrications shall be constructed as indicated on the Drawings and as specified herein.

2-3.01. Stairs. Stairs shall be fabricated to the dimensions, arrangements and sizes indicated on the Drawings. Stairs shall be true to line and slope, shall be rigidly supported, and shall be braced and tightened to prevent movement. All treads shall be level and in perfect alignment and spacing. Handrails shall be in alignment and rigidly connected.

After installation, stairs shall be rigid and shall not sway noticeably or deflect under foot traffic. If necessary to prevent noticeable movement, additional supports or bracing shall be provided.

2-3.01.01. Stair Design. Stairs shall be designed by the stair supplier in general accordance with details indicated on the Drawings. The design shall comply with all applicable provisions of the local building code, ANSI A117.1, and OSHA as applicable. The drawings shall be sealed by a professional engineer registered in the state of the project. If requested, calculations shall be submitted to Engineer.

The completed fabrications shall support a uniform live load of 100 lbs per square foot and a concentrated load of 300 lbs applied at the center of the span. Individual treads and platforms shall be designed to support a uniform live load of 100 lbs per square foot or a 300 lb concentrated live load applied on an area of 4 square inches . Vertical deflections under full live load shall be limited to span/240. Stairs and landings shall be braced or otherwise designed to avoid noticeable sidesway.

The stair design and details shall be coordinated with the handrailing and guardrailing supplied. Stair members shall be adequate to accept loads from the rail posts based upon the criteria in the Handrailing, Guardrailing, and Ladders section.

Connections between the stair members and the supporting structure shall be adequate to transfer all loadings, and shall be designed in accordance with all applicable provisions of the AISC manual and ACI 318 Appendix D. The number and type of connections shall comply, at a minimum, with the Drawings. All necessary brackets, bolts, and anchors shall be provided.

2-3.01.02. Nosings. All stair treads shall have non-skid nosings, either fabricated integrally with the tread or attached with stainless steel bolts and self-locking nuts.

2-3.01.03. Grating Stairs. Treads shall be fabricated from grating material in accordance with the grating section.

2-3.01.04. Pan Type Stairs. Not Used.

2-3.01.05. Cast Aluminum Stairs. Not Used.

2-3.02. Checkered Floor Plates. Checkered floor plates shall be painted steel unless specifically designated on the Drawings as galvanized steel, stainless steel or aluminum. Shop welded stiffeners or grating backup shall be provided as indicated on the Drawings. Stiffeners and grating backup shall be of the same material as the checkered plate.

Checkered floor plates which are indicated to be removable shall be detailed and fabricated in sections which weigh no more than 150 lb (667 N), and shall be provided with lifting holes to facilitate removal. Warped or bent plates shall be straightened so they will lie perfectly flat.

Checkered floor plates shall be secured to structural shapes or grating using 3/8 inch stainless steel slotted flathead machine screws at 12 inch centers, Lindapter "Floor-Fast" stepped locking fasteners or as indicated on the Drawings. Connection devices shall not protrude above the plate surface. Access holes shall be provided in the plate if required to allow access to grating hold-down devices beneath the plate.

2-3.03. Stop Plates and Grooves. Stop plates shall be fabricated with the edges accurately finished. Plates shall be provided with suitable lifting handles and angle stiffeners as indicated on the Drawings. Each stop plate shall be permanently marked to identify its intended location.

Stop plate grooves shall be cast iron Neenah "Series R-7501" with all interior surfaces machined.

Stop plate grooves shall be installed plumb and straight within a tolerance of 3/32 inch and with the opposite sides and bottom aligned in a single plane to prevent binding of the stop plate. If necessary to meet this requirement, a space shall be boxed out for guides, and the guides grouted in place later. Stop plates shall be set in place as needed for testing and startup procedures.

2-3.04. Basin Effluent Launders. Not Used.

2-3.05. Basin Weir Plates. Clarifier weir plates shall be fabricated to dimensions indicated on the Drawings, with top surface cut to shape, and shall be 316 SS. The weir crest edges shall be sharp, leveled, and true to a tolerance of plus or minus 0.0625 inch

per 12-foot length of furnished weir plate. The dimensions, spacing, hole locations, and sizes for required vertical and horizontal adjustment, butt plates, hardware, and fasteners for the rectangular weirs shall be as shown on the Drawings. V-notch weirs shall be horizontal with multiple "V" notches cut into the top edge. Before installation, surfaces in contact with concrete shall be given a heavy coating of sealant as specified in the caulking section. Weir plates shall be adjusted after installation to provide uniform overflow rate at all points.

2-3.06. Scum Baffles. Not used.

2-3.07. Metering Weirs. Not Used.

2-3.08. Bar Screens. Covered in other Sections.

2-3.09. Lime Troughs. Not Used.

2-3.10. Runway Beams. Steel beams used as underhung crane or hoist runways shall be straight and level. The upper surface of the lower flange of each beam shall be smooth, with all projections ground off. Joints shall be close-fitting and free from unevenness. The beams shall be rigidly supported in exact alignment. A section of each runway beam shall not be installed until after the crane or hoist has been installed.

Stops as recommended by the crane or hoist manufacturer shall be bolted in place on each end of each runway beam to limit the travel of the crane or hoist. Stops shall be so located that the crane or hoist does not come into contact with any part of the structure or piping. If the crane or hoist is required to be powered, at the power feed end of the runway the stops shall be designed so that the cable trolleys will pass beneath the stops. The stops shall be so located that there is sufficient room on the runway for storage of the cable trolleys beyond the stops. Secondary stops shall be provided for the cable trolleys.

2-3.11. Crane Rails. Not Used.

2-3.12. Structural Steel Bolted Connections. Bolt holes shall have a diameter nominally 1/16 inch larger than the nominal bolt diameter. Bolt holes for one ply of vertical diagonal bracing connections may be oversized to a diameter nominally 3/16 inch larger than the nominal bolt diameter.

2-4. SHOP COATING. All structural and miscellaneous metal items shall be shop coated as specified herein. The requirements for field painting are covered in the protective coatings section.

Contact surfaces of structural steel slip critical bolted connections shall not be shop coated. Contact surfaces of structural steel bearing type bolted connections may be shop coated.

2-4.01. Cleaning. Surfaces shall be dry and of proper temperature when coated, and shall be free of grease, oil, dirt, dust, grit, rust, loose mill scale, weld flux, slag, weld spatter, and other objectionable substances. Articles to be galvanized shall be pickled before galvanizing. All other ferrous metal surfaces shall be cleaned by solvent, high-speed power wire brushing or by blasting to the extent recommended by the paint manufacturer and as required in the protective coatings section.

2-4.02. Edge Grinding. Sharp projections of cut or sheared edges of ferrous metals which will be submerged in operation, except for items specified to be hot-dip galvanized, shall be ground to a radius as needed to ensure satisfactory paint adherence and as required in the protective coatings section.

2-4.03. Prime Painted Steel. Unless otherwise specified or indicated on the Drawings, all ungalvanized structural and miscellaneous steel shall be given a universal prime coat in the shop after fabrication. The dry film thickness of the universal primer shall be at least 5 mils . Steel surfaces shall be prime-coated as soon as practicable after cleaning. Steel shall not be moved or handled until the shop coat is dry and hard.

2-4.04. Galvanizing. Steel materials required to be galvanized are indicated on the Drawings. All galvanizing shall be done by the hot-dip process after fabrication. An approved zinc-rich paint shall be used to touch up minor coating damage. Materials with significant coating damage shall be regalvanized or replaced.

Bolts, nuts, and washers shall be galvanized when connected materials are galvanized or where indicated on the Drawings. The use of zinc-plated bolts will not be acceptable.

2-4.05. Stainless Steel. Unless otherwise specified, all items fabricated from stainless steel shall be thoroughly cleaned and degreased after fabrication. Pickling or a light blast cleaning shall produce a modest etch and remove all embedded iron and heat tint. Surfaces shall be subjected to a 24-hour water test or a ferroxyl test to detect the presence of residual embedded iron and shall be retreated as needed to remove all traces of iron contamination. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

2-4.06. Aluminum. All surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a coat of epoxy enamel.

2-4.07. Castings. Shop coating of miscellaneous iron castings will not be required.

2-4.08. Other Surfaces. Painting of zinc coated steel or bronze surfaces will not be required.

PART 3 - EXECUTION

3-1. STRUCTURAL STEEL ERECTION. Structural steel shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevations of the top of floor and roof members shall be within 1/16 inch of the elevations indicated on the Drawings. The faces of girts and other supporting members for rigid wall panels shall be in vertical planes within a maximum variation of 1/8 inch .

All members and parts, as erected, shall be free of warps, local deformations, and unauthorized bends. All parts shall be assembled accurately as indicated on the Drawings. Light drifting will be permitted to draw parts together, but drifting to match unfair holes will not be permitted. Any enlargement of holes necessary to make connections in the field shall be done by reaming with twist drills and only with the approval of Engineer. Enlarging holes by burning will not be permitted.

Setting of Bases and Bearing Plates shall be as follows: Clean concrete surfaces of bond reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates. Set loose and attached baseplates and bearing plates for structural members horizontally on wedges, leveling nuts, or other adjustable devices. Tighten the anchor bolts after the supported members have been positioned and plumbed. Grouting of baseplates shall be as specified in Section 03600 - Grout. Grout prior to placing loads on structure.

All materials shall be erected in compliance with OSHA 29 CFR, Part 1926, Subpart R, and with all other applicable OSHA and local safety regulations.

3-1.01. Inspection and Testing. Special inspection will be performed in accordance with the applicable building code. The erector shall provide access as needed to facilitate all inspections and shall provide timely notification during erection when inspection milestones are approaching.

3-2. STRUCTURAL STEEL BOLTED CONNECTIONS. Unless otherwise indicated on the Drawings, bolted connections for structural steel, as defined in the AISC manual, shall be made with ASTM F3125 high strength bolts conforming to the "Specification for Structural Joints Using High-Strength Bolts" as approved by the Research Council on Structural Connections. The method of installation, pretensioning procedures, bolting equipment and tools shall likewise conform to the above referenced standard.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts, or washers, shall be free of loose mill scale, dirt, burrs, oil, and other foreign material that would prevent solid seating of the parts.

Beveled washers shall be used when the bearing faces of bolted parts have a slope of 1:20 or greater with respect to a plane perpendicular to the bolt axis. Bolt length shall be increased as needed to accommodate the beveled washers.

If oversized holes are provided in an outer ply, a hardened flat washer shall be installed over each hole during bolting. Load indicator washers shall not be substituted for hardened flat washers required for oversized holes.

Tightening of each connection assembly shall progress systematically from the most rigid part of the joint toward the free edges until all have been sufficiently rotated or the load indicator washers on all bolts have been closed to the average gap stipulated by the load indicator washer manufacturer.

Bolts in all structural steel connections, both bearing and slip critical, shall be fully pretensioned in accordance with the AISC standards unless specifically noted otherwise on the Drawings. The calibrated wrench method of pretensioning bolts will not be acceptable. Acceptable pretensioning methods are as follows:

Connection Type	Acceptable Pretensioning Method
Bearing	Turn of the nut method and load-indicator washers are acceptable. Tension control (twist-off) type bolts may be used only if approved by Engineer.
Slip-Critical	Load indicator washers.

3-2.01. Turn of the Nut Method. The bolt, nut, and material shall be match marked. A wax lumber marker or paint shall be used to clearly mark the assembly.

3-2.02. Load-Indicator Washers. Load indicator washers shall be installed in accordance with the manufacturer's recommendations, as supplemented herein. To facilitate proper tightening of fastener assemblies with load indicator washers, a hardened flat washer shall be installed under the turned element (bolt head or nut) and between the turned element and the load indicator washer protrusions, in all cases. Whenever possible, the load indicator washer shall be installed on the head end of the bolt. If the bolt head will not be visible for inspection of the indicator washer after installation, or if the bolt head must be turned to tighten the assembly, the load indicator washer may be installed on the nut end of the bolt.

3-2.03. Tension Control (Twist-off) Bolts. Patented tension control bolts shall be of equivalent size and strength to the indicated high strength bolts, and shall be installed in

strict accordance with the manufacturer's instructions. Load-indicator washers are not required on tension control bolts.

3-3. MISCELLANEOUS STEEL BOLTED CONNECTIONS. Connections for miscellaneous steel fabrications not included in the AISC definition of structural steel may be made with unfinished bolts unless indicated otherwise on the Drawings. Unless otherwise indicated on the Drawings all unfinished bolts shall be snug tight.

3-4. STRUCTURAL, STAINLESS, AND MISCELLANEOUS STEEL WELDING. Welding and related operations shall conform to applicable provisions of AWS D1.1 for steel and AWS D1.6 for stainless steel. All welding shall be performed in accordance with written procedures, using only those joint details which have prequalified status. All welding shall be performed by welders qualified in accordance with the American Welding Society.

All welds shall be visually inspected in accordance with AWS procedures.

Welds not dimensioned on the Drawings shall be sized to develop the full strength of the least strength component of the connection.

Where structural or miscellaneous steel connections are welded, all butt and miter welds shall be continuous and, where exposed to view, shall be ground smooth. Intermittent welds shall have an effective length of at least 2 inches and shall be spaced not more than 6 inches apart.

Surfaces to be welded and surfaces within 2 inches of a weld shall be free from loose or thick scale, slag, rust, moisture, grease, paint and other foreign materials that would prevent proper welding or release objectionable fumes.

Only shielded metal arc, gas metal arc, flux cored arc, submerged arc, and gas tungsten arc welding are permitted. For flux cored arc welding, only E70xx one (1) or five (5) wire electrodes with supplemental gas shielding shall be permitted. Use of electroslag or electrogas welding processes or the short-circuiting transfer mode of the gas metal arc process will not be acceptable.

Field welded connections shall not be substituted for field bolted connections indicated on the Drawings.

Deformed bar anchors, headed studs, concrete anchors and shear connectors shall be welded with an automatic stud welding gun per the manufacturer’s recommendation. Hand welding will not be acceptable.

3-5. STRUCTURAL AND MISCELLANEOUS ALUMINUM. Unless otherwise noted, all work shall conform to applicable provisions of the Aluminum Association "Specification for Aluminum Structures".

3-5.01. Connections. Connections not specifically detailed on the Drawings shall develop the full strength of the least strength member of the connections. Bolted connections shall be all-bolted bearing type, equipped with a helical spring lock washer under the stationary element (bolt head or nut) and a flat washer under the turned element. All bolts shall be fully tightened. Bolts and nuts for structural aluminum connections shall be stainless steel. Bolts and nuts for nonstructural miscellaneous aluminum assemblies shall be stainless steel or aluminum. A sufficient number of bolts shall be provided in each connection to develop the shear strength of the member.

Welded connections shall be made in accordance with the American Welding Society D1.2, Structural Welding Code - Aluminum. All welding shall be performed by welders qualified in accordance with American Welding Society. Welds shall be free of porosity, cracks, holes, and flux. Welded connections shall not be substituted for bolted connections without prior approval of Engineer.

Welding of aluminum work shall be on the unexposed side as much as possible in order to prevent pitting and discoloration.

3-5.02. Erection. Structural aluminum shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevation of horizontal members shall be within 1/16 inch of the elevation indicated on the Drawings.

Baseplates shall be set level in exact position and grouted in place.

3-6. LEVELING TOLERANCES FOR WEIRS. Install weirs level and true to elevation as shown on the Drawings. Prior to substantial completion, all weir plates shall be set to the proper elevation and leveled. The Contractor shall give the Owner's Representative at least two weeks' notice prior to leveling weir plates. The Owner's Representative will in turn establish bench marks within 100 feet of each weir installation. The weir plates shall be set using an automatic (self-leveling) level based on the established bench mark elevation. Weir plate crest and V-notch elevations shall be set to within 0.01 foot of the elevation shown on the Drawings. Weirs shall be leveled such that there is a maximum variation of 0.01 foot between any two points along the weir.

End of Section

SECTION 06610

WEIRS AND BAFFLES

PART 1 - GENERAL

1-1. SCOPE. This section covers the work necessary to furnish and install the fiberglass baffles, complete, at the SRWRC Clarifiers. Weirs shall be 316 SS.

Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, and maintenance.

See CONDITIONS OF THE CONTRACT and General Conditions, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

1-2. SUBMITTALS. Submittals shall be in accordance with General Conditions. In addition, the following specific information shall be provided to the Engineer:

1. Complete specifications, drawings, and descriptive literature on the equipment and materials and any exceptions to the Specifications.
2. Type and name of interior and exterior resins.
3. Type, name, and thicknesses of glass reinforcements, and minimum glass content.
4. Relevant experience references.
5. Manufacturer's data.

1-3. WARRANTY. Provide a warranty against defective equipment and workmanship in accordance with the General Conditions of the Contract Documents.

1-4. RELATED WORK SPECIFIED UNDER OTHER SECTIONS. The following sections, although not limited to these sections, in this Specification describe work closely related to this section; all work performed by the Contractor shall be in accordance with these related Specifications.

Section	Item
Division 1, GENERAL REQUIREMENTS	General Requirements
Division 5, METALS	Anchor Bolts

PART 2 - PRODUCTS

2-1. GENERAL. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only.

Fiberglass baffles, troughs, butt plates, supporting brackets, and fasteners, shall be suitable for service in a sewage treatment plant in uncovered basins exposed to sunlight.

The fiberglass may be in an atmosphere containing high concentrations of hydrogen sulfide. Accordingly, all parts of the assembly shall be resistant to corrosion under these conditions. All metal used on the assemblies and fasteners shall be Type 316 stainless steel minimum.

2-2. MANUFACTURERS

Tracom, Inc;
Warminster Fiberglass Company;
Leo-Lite as manufactured by Leopold Company;
Or equal.

2-3. EQUIPMENT LOCATIONS. Furnish baffles, troughs, support brackets, and fasteners at the following locations:

Location	Product
Clarifiers	Scum baffles

2-4. MATERIALS DESCRIPTION

The resins and fiberglass reinforcing material shall be consistent with the environmental conditions and structural requirements. Except as hereinafter modified and/or amplified, the products under this section shall meet the requirements of Voluntary Product Standard PS-15-69 for custom contact-molded reinforced polyester chemical-resistant process equipment for fiberglass members of 1/4-inch minimum thickness.

Interior resin shall meet or exceed resistance to corrosion, similar to ATLAC 382 or Derakane 411. Pigmentation and ultraviolet inhibitors for protection from ultraviolet radiation shall be provided. A maximum of 4 percent by weight of thixotropic agent, Cab-O-Sil, or equal, may be added to the resin to prevent runoff. Edges shall be sealed to prevent wicking. Resin with sufficient thixotropic agent added to form a paste shall be used to seal any factory machined or cut edges or field cut edges.

Custom contact molded baffles and troughs shall meet the following: Glass reinforcement shall consist of chemically bonded surfacing mat and either chopped strand, chopped

strand mat, woven roving, or woven cloth, or any combinations thereof as required by the finished product. Surfacing mat shall be Type A or Type C, 10 to 20 mils thick, with a silane finish and a styrene-soluble binder. The glass content of this layer shall not exceed 23 percent by weight. Chopped strand and chopped strand mat shall be Type E glass with silane finish and styrene-soluble binder. Strand shall not be larger than No. 130. The glass content of the finished laminate shall not be less than 30 percent by weight. Woven cloth or woven roving (60-end maximum) shall be Type E glass with "Volan" methracrylate chromic chloride or silane type finish. All baffles and troughs shall be color molded with white pigmentation and have nexus veil for UV protection.

Baffles and troughs shall be plastic laminate, 1/4 inch minimum thickness, and accurately formed by a molded method. All machined edges shall be resealed as described above. Butt plates for joining adjacent weir plates shall be of the same material as the weir plates and shall be fastened with stainless steel hardware to be included by the weir manufacturer. All mounting brackets and hardware shall be as shown on the Drawings.

Both surfaces of the plate shall be smooth and resin-rich and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks, or crazes. The mold surface of the plate shall be reinforced with surfacing mat. This shall be followed with 3 ounces or more of chopped strand mat in a minimum of two layers. No other glass product is permitted between these layers. Final laminate thickness shall be within plus or minus 10 percent of nominal laminate thickness. Void content of the completed laminate shall not exceed 2-1/2 percent of laminate by volume.

All metal used on the assemblies and fasteners shall be Type 316 stainless steel.

The depth of the scum baffle shall be increased upstream and downstream of the scum beach as indicted on the Drawings. The scum baffle shall be designed so that at least 2 inches [50 mm] of horizontal and vertical adjustment is provided. Scum baffles, and support brackets shall be fabricated in accordance with ANSI/AWWA F102-07.

2-5. EQUIPMENT DESCRIPTION

Baffles and Troughs: Dimensions as shown on the Drawings.
Vertical surfaces shall be smooth and suitable for mounting weir plates.

Provide leaktight gasket between trough and weir plate.
Provide flanged end on trough for wall connect as shown on Drawings.

Troughs shall be designed and constructed to withstand buoyant forces without excessive stress or deflection with liquid level on outside of trough. Troughs shall be anchored at ends and at intermediate support points as shown on Drawings. Trough

deflection shall not exceed 1/4-inch vertically from either buoyant forces acting on an empty trough or the weight of water in the trough.

Concrete Anchors: All concrete anchors shall be 1/2-inch minimum diameter, Type 316 stainless steel, and installed as shown on the Drawings.

PART 3 - EXECUTION

3-1. SHIPPING, HANDLING, STORAGE, PROTECTION REQUIREMENTS. The equipment provided under this section shall be shipped, handled, stored, and protected in accordance with the manufacturer's written instructions and in accordance with Section 01600, MATERIAL AND EQUIPMENT. The manufacturer shall package for shipment all equipment specified herein. The plates shall be packaged to protect surfaces and edges during shipment and storage on site.

3-2. INSTALLATION. The Contractor shall store and install the equipment specified herein in accordance with manufacturer's recommendations and installation practices.

Field cutting of plates shall not be allowed, except for a final make-up piece for each straight section. Press all cut ends per manufacturer's recommendation.

Contractor shall coordinate the scum baffles, and support brackets] with all perimeter guardrails, guardrail support brackets, launder covers, and launder cover support brackets that are supplied by others.

Troughs shall be anchored to the concrete clarifier walls and beams. Troughs shall be sealed against the concrete to provide a leaktight joint.

Leveling Tolerances: Install level and true to elevation as shown on the Drawings.

Prior to substantial completion, all baffles shall be set to the proper elevation and leveled. The Contractor shall give the Owner’s Representative at least two weeks notice prior to leveling baffles. The Owner’s Representative will in turn establish benchmarks within 100 feet of each weir installation. Their weir plates shall be set using an automatic (self-leveling) level based on the established bench mark elevation. Weir plate crest and V-notch elevations shall be set to within 0.01 foot of the elevation shown on the Drawings. Baffles shall be leveled such that there is a maximum variation of 0.01 foot between any two points along the weir.

Painting: Not required for UV protected laminates.

3-3. MANUFACTURERS' CERTIFICATE. Provide manufacturer's certificate(s) in accordance with Section 01640, MANUFACTURERS' SERVICES.

END OF SECTION

SECTION 07081

FLASHING AND SHEET METAL

PART 1 - GENERAL

1-1. SCOPE.

1-1.01. Contractor shall furnish all labor, materials, equipment and incidentals required to provide and install flashing and sheet metal as shown and as specified.

1-1.02. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1-1.03. Coordination: Review installation procedures under other section and coordinate the installation of items that must be installed with the roof insulation.

1-2. SUBMITTALS.

1-2.01. Product data: Indicate product description, finishes and installation instructions, including interface with adjacent materials and surfaces.

1-2.02. Shop drawings: Indicate material types, sizes, shapes, thicknesses, finishes, fabrication details, joint details, anchors, connections, expansion joints, and relations to adjacent work.

Draw details and profiles to quarter size scale.

Include on detailed shop drawings, locations of sleepers and required fastening strips to secure metal work where sheet metal is applied to other than wood surfaces.

1-2.03. Samples, submit as follows:

1. Special finishes: 6" x 6" samples of manufacturer's standard colors for Engineer's color selection, including a clear coated mill finish sample.
2. Manufactured expansion joint covers, copings, gravel stops, flashing reglets, and other flashing items: 1'-0" length in style and finish specified.

1-2.04. Quality control submittals: Certificates: Submit certificates indicating materials supplied or installed are asbestos free.

1-3. QUALITY ASSURANCE.

1-3.01. Reference Standards. Comply with all federal and state laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. American Iron and Steel Institute (AISI)
2. American Society for Testing and Materials (ASTM)
3. Copper Development Association, Inc. (CDA)
4. Sheet metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

1-3.02. Industry Standards:

1. AISI: Stainless Steel Data Manual, 1968 Edition.
2. CDA: Contemporary Copper in Architecture, 1973 Edition.
3. SMACNA: Architectural Sheet Metal Manual, 4th Edition, October 1987.

1-3.03. Pre-installation conference: Prior to beginning work, conference will be held to review work to be accomplished.

Particular requirements are specified in Loose Single Ply Membrane section.

1-4. DELIVERY, STORAGE AND HANDLING. Acceptance at site: Handle materials to prevent damage to surfaces, edges and ends of sheet metal items. Reject and promptly remove damaged materials from site.

Storage and protection: Store materials off ground, under cover. Protect from damage and deterioration.

1-5. SEQUENCING AND SCHEDULING. Coordinate requirements of this section with work described under Manufactured Roof section. Use flat stock matching respective roofing for shop fabricated flashings, closures and accessories.

1-6. WARRANTY. Warrant flashing and sheet metal work to be free of defects in materials and workmanship; combine warranty with roofing warranty.

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2-1. MATERIALS.

2-1.01. Sheet metal:

General: Follow gauge, thickness, or weight requirements in SMACNA Manual for intended use, but not less than indicated below.

Sheet Aluminum at .038" min. allow. Standard Color Kynar.

Sheet lead: Minimum 4 lbs. PSF hard type.

2-1.02. Soldering materials:

Solder: Meeting ASTM 032-76, alloy grade 50A, 50% pig lead and 50% block tin.

Solder flux for:

a. Stainless steel and copper: Muriatic acid neutralized with zinc.
b. Lead: Non-corrosive rosin.

2-1.03. Fasteners: Same material or compatible with sheet metal being fastened.

1. Nails: Flathead, needle point, not less than 12 gauge; sufficient length to penetrate substrate 1" minimum.
2. Expansion shields: Lead sleeves.
3. Screws: Self-tapping type with round heads.
4. Bolts: Furnished complete with nuts and washers.
5. Rivets: Round head, solid shank.
6. Blind clips and cleats: Same gauge as sheet metal.

2-1.04. Caulk: Sonneborn NP-l Flexible Lap Sealant. G.E. Silicone as shown.

2-2. FABRICATION.

2-2.01. Shop Assembly:

General: Fabricate sheet metal in accord with reviewed shop drawings and industry standards. Form sheet metal work with clear, sharp and uniform arises. Hem exposed edges. Fabricate corners with minimum 2'-0" returns each side of return; fully seal joints.

Stainless steel, aluminum and copper materials: Roughen edges of stainless steel with emery cloth before soldering.

Solder sheet metal joints with heavy, well heated coppers. Pre-tie joints not less than 1-1/2" wide. Sweat solder through seam's full width. Provide 1" minimum soldered joints.

Neutralize remaining acid with ammonia or baking powder solution; rinse with water.

Provide linear sheet metal items in 10'-0" sections minimum, except as otherwise noted.

Form flashing using single pieces for full width.

Form specified sheet metal items in accord with SMACNA details and existing adjacent work; gauge indicated in SMACNA description of particular plate, but no less than .038" thickness.

PART 3 - EXECUTION

3-1. INSPECTION.

3-1.01. Verification of Conditions: Verify locations of all roof openings and penetrations are in accord with reviewed shop drawings.

Examine conditions and substrates under which products of this section are to be installed; submit written notification of unacceptable conditions or substrates.

Submit copy of installer's report to the Engineer within 72 hours of report receipt.

Proceeding with construction activity of this section:

a. Prior to correction of unacceptable conditions or substrates are prohibited.
b. Indicates installer's acceptance of conditions and substrates.

3-2. INSTALLATION.

3-2.01. Sheet Metal: Install work in accord with reviewed shop drawings and industry standards. Provide sheet metal items true to line, without buckling, creasing, warp or wind in finished surfaces.

Coordinate flashing at roof surfaces with roofing work to provide weathertight condition at roof terminations.

Perform field joining of lengths specified for shop fabrication, but in lengths no shorter than 10'-0" except at closure pieces.
Isolate dissimilar materials to prevent electrolysis. Separate using bituminous paint or roofing felt.

Seaming:

a. Comply with SMACNA Plates #99, #100 and other applicable plates.
b. Flat-lock seams: Finish not less than 3/4" wide.
c. Soldered lap seams: Finish not less than 1" wide.
d. Other lap seams: Overlap not less than 4" unless otherwise indicated.
e. Seams: Orient properly for direction of water flow.
f. Flatlock seams with cleats soldered.
g. Lap seams occurring in members sloping 45" or more, 4" minimum; bed in with butyl sealant.
h. Perform soldering in same manner indicated in FABRICATION Article.

Secure sheet metal items using continuous cleats, clips and blind fasteners as indicated; exposed face fastening is prohibited.

Fastening:
Nails: Confine to one edge only of flashing 1'-0" or less in width. Space nails at 4" O.C. Maximum. Provide neoprene washers for nails.

Cleats: Continuous; form to profile of item being secured.

Clips: Minimum 2" wide and continuous; form to profile of item being secured. The clips are continuous and the cap flashing replacement.

Form joints in linear sheet metal to allow for 1/2" minimum expansion at 20' -0" OP.C. maximum and 8'-0" from corners. Provide 1'-0" wide back-up plate at intersections. Form plates to profile of sheet metal items. Apply linear sheet metal items in full bed of butyl or urethane caulk over back-up plate.

Gutters and downspouts: Construct with riveted and soldered joints, lapped 1" minimum in direction of flow, provide 3/4" minimum expansion joints at 60`-0" O.C. maximum. Form expansion joints in accord with SMACNA Manual, Plate #7 for gutters up to 20 gauge; Plate #11, 20 gauge and heavier.

Hang gutters with high points equidistant from downspouts, evenly sloped toward downspouts. Support gutters in accord with SMACNA Manual, Plate #14A.

Secure downspouts to exterior walls at 6'-0" O.C. maximum using straps and expansion type fasteners. Lap downspout joints, 1-1/2" minimum and solder.

Finish gutters, downspouts and hangers; required, copper material to match existing.

Roof Penetration Flashing: Pipe penetrations: Provide flashing extending 2'-6" onto roofing felts each direction for pipes penetrating roof. Flash in accord with slate roofing

manufacturer's requirements.

End of Section

SECTION 07100

WATERPROOFING AND MOISTUREPROOFING

PART 1 - GENERAL

1-1. SCOPE. This section specifies waterproofing and moistureproofing of concrete surfaces and below grade masonry surfaces.

PART 2 - PRODUCTS

2-1. MATERIALS.

2-1.01. Waterproofing and Moistureproofing Coatings: Waterproofing and moistureproofing coating shall be PVC lining where shown on the Drawings or epoxy resin. Acceptable epoxy resin products are Tnemec Series 69, Ameron Amercoat 351, and Porter 7600 Series Magna Coat. Each of these is a polyamidoamine epoxy.

2-1.02. Waterproofing Membrane: Waterproofing membrane shall be Bituthene as manufactured by W.R. Grace and Company, Jiffy Seal as manufactured by Protecto Wrap Co., or equal. Volclay Panels or Bentonize bentonite system are acceptable alternates, except where membrane is required between concrete slabs or where there is concrete over waterproofing membrane.

Protective Board: Protective board shall be 1/2-inch asphalt impregnated celotex insulation board.

2-1.03. Moistureproofing Underlay:

1. Plastic Membrane: Plastic membrane for moistureproofing underlay shall be polyethylene film with a thickness of 6 mils.
2. Pressure Sensitive Tape: Pressure sensitive tape shall be 2-inch wide polyethylene tape.

PART 3 - EXECUTION

3-1. CONSTRUCTION.

3-1.01. Waterproofing Coating:

Location: Not used.

3-1.02. Moistureproofing Coating:

Location: Moistureproofing will be required around the South River Headhouse. Moistureproofing coating shall be applied to the earth side of concrete or masonry walls which are below grade and are common with rooms, tunnels, or galleries to be occupied by equipment, piping, or personnel. Moistureproofing coating is not required for walls to be provided with waterproofing membrane or for walls which are poured directly against an excavated surface.

Surface Preparation: Preparation of concrete shall conform to Paragraph Surface Preparation. Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with sealer or block filler compatible with the specified primer. Sealer or filler shall dry a minimum of 48 hours prior to application for prime coat.

Application: One or more coats shall be applied at the manufacturer's recommended dry film thickness. The number of finish coats shall be sufficient to produce a total dry film thickness of at least 16 mils. Drying time between coats shall be as recommended by the coating manufacturer.

3-1.03. Waterproofing Membrane:

Location: Not used.

3-1.04. Moistureproofing Underlay:

Location: Unless otherwise specified, moistureproofing underlay shall be provided under concrete floors or floating slabs-on-grade including those deposited on drain rock.

Surface Preparation: Backfilled surfaces to receive moistureproofing underlay shall be leveled off and smoothed over to minimize contact with sharp edges.

Application: At joints, moistureproofing membrane shall be lapped 12 inches and sealed with pressure sensitive tape. Where pipes and conduits pass through the membrane, they shall be wrapped tightly with separate sheets of membrane which shall then be sealed with tape to the main membrane. Reinforcing steel or wire mesh shall be supported by chairs with flat bases to protect the membrane.

End of Section

SECTION 07190

VAPOR BARRIER

PART 1 - GENERAL

1-1. SCOPE. The Contractor shall furnish all materials, labor, equipment, and incidentals required to perform all vapor barrier work and related work necessary for the proper completion of the project as required by the Drawings and as specified herein.

1-2. SUBMITTALS. Submit to the Engineer as provided in the General Conditions for shop drawings, detailed information on materials proposed and installation methods.

PART 2 - PRODUCTS

2-1. MOISTURE BARRIER (UNDER CONCRETE SLABS). Where so indicated on the Drawings, provide a moisture barrier consisting of pre-molded, membrane meeting the standard of ASTM E-96, Method B, 1980 and ASTM D781, 1968, ASTM D1228, 1964.

2-2. OTHER MATERIALS. Provide other materials, not specifically described but, required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3-1. SURFACE PREPARATION. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3-2. INSTALLATION. Install vapor barrier under concrete slabs-on-grade, sealing all lap joints, around all protrusions, and at slab edges.

Vapor barrier to extend continually from the top of footing or to be sealed to the foundation wall, or to extend to the outside edge of a monolithic slab or patio.

Vapor barrier should be installed with all seams lapped at least 12 inches, taped and sealed with plastic roof cement, or other flexible air tight seal as approved by the Engineer.

All punctures in vapor barrier to be repaired with same material, lapped at least 12 inches, taped and sealed.

Field fabricate a sealing boot around all utility entries and other penetrations and seal boot airtight to vapor barrier and conduit.

End of Section

Section 07410

FIBERGLASS REINFORCED PLASTIC (FRP) LOUVERS

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and erection of fiberglass reinforced plastic louvers, including trim, flashings, clips, as indicated on the drawings and as specified herein.

1-2. GENERAL. The materials to be furnished and installed under this section include, but are not limited to:

Fiberglass reinforced plastic louvers
Flashings, trim, and closures
Insect screening, Clips, spacers, and shims
Caulking and sealing materials
Fasteners

1-3. SUBMITTALS. Before fabrication, detailed fabrication and erection drawings shall be submitted in accordance with Section 01300, Shop Drawings, Product Data, and Samples. Submittals shall include jointing, trim, and flashing details, including termination and penetrations.

1.4. QUALITY ASSURANCE. Applicable standard: ASTM D 4216 Specification for Rigid Poly Vinyl Chloride (PVC) and related Plastic building products compounds.

1-5. HANDLING AND STORAGE. The materials shall be handled in a manner which will prevent bending, dents, scratches, or damage of any kind. Damaged units and accessories will be rejected, and shall be replaced by and at the expense of the Contractor promptly after rejection. Materials shall be stored under cover at all times.

1-6. WARRANTY. The manufacturer of the metal roof systems shall furnish to the Owner a warranty covering materials and finish for a period of 20 years from the date of acceptance.

PART 2 – PRODUCTS

2-1. MATERIALS. Materials shall conform to the following:
Wall louvers basis for design is ResoFLO fiberglass reinforced plastic louvers by Resolite, a Stabilit America Co., 285 Industrial Drive, Moscow, TN 38057, Ph: 888-737-6548.

Glass reinforcement for the louver frame and blades shall include unidirectional filaments to provide high tensile and flexural properties and overall section stiffness. In addition, continuous strand mat shall be included to contribute to the transverse properties of the louver. Glass content shall be a minimum of 40% by weight. C/W Barrier shall be on all surfaces to provide a resin rich surface to increase corrosion resistance and UV protection. Resin shall be high quality isophthalic halogenated polyester, having a flame spread classification of 25* or less. Additional protection shall be provided with the use of UV stabilizers.

STATIONARY LOUVER, MODEL SBRK6 45º Louver frames shall be 6" deep channel type and shall be 1/4" minimum thickness.

Louver blades shall be "K" style design and shall be 1/8" minimum thickness. Birdscreen shall be polyethylene mesh

2-2. FINISH. Panels, trim, seam corners, flashings, and all exposed appurtenances shall have a smooth finish. Color shall be Gray and coloring shall be achieved through the use of pigments impregnated through the entire profile.

2-3. LOUVERS TO BE PROVIDED. Louvers to be provided include, but are not limited to the following:

Chemical Building HVAC Louver: 34” W x 40” H

PART 3 – EXECUTION

3-1. INSPECTION. The applicator shall examine the surfaces on which the work is to be applied. The applicator shall notify the Engineer, in writing, if the surfaces are not suitable to receive the louver panels. Applicator shall obtain and verify all field measurements prior to fabrication of the louver panels.

3-2. FABRICATION. Louver panels, flashings, trim, and accessories shall be fabricated in accordance with the details on the drawings, to tolerances which will ensure proper fit, appearance, and weathertightness when erected.
Side joints for exterior application shall be of interlocked construction, shall be sealed full or gasketed at the factory, and shall be completely resistant to moisture and air infiltration when erected. Panels shall be fabricated in lengths which will eliminate horizontal joints in the completed construction. Flashings shall include all materials referred to on the drawings as flashings, trim, or closures.

3-3. INSTALLATION. Workmanship shall conform to standards set forth in the Materials shall be installed by experienced mechanics who are directly employed by the

louver manufacturer or by an erector currently franchised by the manufacturer and who has experience in installing projects of similar or greater complexity.

Louvers shall be installed complete with all hold down clips, fasteners, flashings, and accessories, in accordance with the manufacturer's instructions. All horizontal lines shall be true and vertical lines shall be plumb and in alignment. All trim, closure panels, and flashings shall be installed to provide watertight joints. Any damaged materials shall be replaced; only minor scratches and abrasions may be touched up.

3-4. CLEANING. After installation is complete, all exposed surfaces of the louver panel, including flashings and accessories, shall be cleaned of all dust, dirt, grease, and other foreign material to the satisfaction of the Engineer.

End of Section

Section 08110

STEEL DOORS AND FRAMES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of hollow metal doors and frames. Unless otherwise indicated or specified, all steel doors shall be flush type.

Structural steel door frames and finish hardware are covered in the Structural and Miscellaneous Metals section and the Finish Hardware section, respectively.

1-2. GENERAL. Doors, frames, and appurtenances shall be furnished and installed as specified herein and in accordance with the details and arrangements indicated on the Drawings.

Doors, frames, and appurtenances furnished under this section shall be fabricated and assembled and erected, in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

1-3. SUBMITTALS.

A. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data for Credit IEQ 4.1: For adhesives, glues and insulation used at Site, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.4: For insulation products, documentation indicating that product contains no urea formaldehyde.

B. General Submittals:

1. Complete detail drawings of all items specified herein shall be submitted in accordance with the Submittals Procedures section. Drawings shall show elevations of each door type; details of each frame type; location or identification of each item; typical and special details of construction; methods of assembling sections; location and installation requirements for hardware; size, shape, and thickness of materials; joints; connections; and finish.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Deliver Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damages of any kind. Damaged materials shall be promptly replaced.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN CRITERIA.

2-1.01. Governing Standard. Except as modified or supplemented herein, all steel doors and frames shall conform to the requirements of ANSI/SDI 100, Level 2, Model 2.

2-1.02. Metal Thicknesses. Metal thicknesses and gages of steel sheet metal specified herein are the minimum required. Gages refer to US Standard gage.

2-1.03. Nomenclature. The nomenclature used herein conforms to ANSI/SDI A250.8.

2-2. ACCEPTABLE PRODUCTS. Internally reinforced doors and accompanying frames shall be equivalent to the following or approved equal:

The Ceco Corporation "Trio" with minimum 58% recycled steel content.

Curries Manufacturing Company "Series 777" with minimum 58% recycled steel content.

Flush panel doors with foamed-in-place polyurethane or rigid urethane core and accompanying frames shall be equivalent to the following or approved equal:

The Ceco Corporation "Imperial"

Pioneer Industries "CHT Series"

Raised panel doors with foamed-in-place polyurethane core and accompanying frames shall be equivalent to the following or approved equal:

The CECO Corporation "Versadoor"

2-2.01. Fire Doors.

Fire doors shall be of the same construction as internally reinforced doors, except where building codes require that certain fire doors meet a specific maximum temperature rise requirement. Fire door and frame will be required in the lower level of the South River Headhouse, requiring a 450°F maximum temperature rise in first 30 minutes of exposure shall be equivalent to the following or approved equal:

The Ceco Corporation "Trio" with minimum 58% recycled steel content.

Curries Manufacturing Company "Series 777" with minimum 58% recycled steel content.

2-3. MATERIALS. Materials used in the manufacture of steel doors and frames shall be as follows:

Doors and Frame	ASTM A1008/A1008M or A1011/A1011M, stretcher leveled, commercial quality sheet steel with smooth, clean surface;galvanized, per ASTM A653/A653M with G90 minimum coating.
Internal Reinforcing	ASTM A1008/A1008M, cold-rolled steel.
Fillers for Internally Reinforced Doors	Injected polyurethane foam, CFC and HCFC free.
Thermal Characteristics	R Factor: 11.0 (ASTM C518).
Anchoring Devices	Zinc-plated where exposed; zinc- plated or galvanized where concealed.
Expansion Anchors	As specified in the Anchorage in Concrete and Masonry section.
Tape Sealant	PVC or neoprene closed-cell foam, black, 1/2 inch wide by 1/4 inch thick strip with pressure-sensitive adhesive back; Williams "Everlastic NN-1" or approved equal.

2-4. FRAMES. Frames for doors, transoms, sidelights, mullions, and interior glazed panels shall be formed of steel to the sizes, 14 gage, and shapes required.

2-4.01. Workmanship. The finished work shall be strong, rigid, neat, and free from defects. Molded members shall be fabricated straight and true, with corner joints well formed, and with fastenings concealed where practicable.

2-4.02. Joints. Joints for frames shall be mitered or butted and continuously welded on the reverse side to produce rigid joints which are invisible on the face of the frame. Frame bottoms shall be held rigidly in position by spreader bars to maintain proper alignment during shipment and erection.

2-4.03. Hardware Provisions. Frames shall be prepared at the factory for the specified hardware. Frames shall be mortised, reinforced, drilled, and tapped for mortised hardware, and shall be reinforced for surface-applied hardware. Cover boxes shall be provided in back of all hardware cutouts. Frames for all doors except weatherstripped doors shall be punched to receive silencers, three holes on the lock side of single door frames and one hole for each leaf in heads of double door frames. Lock strikes shall be set out and adjusted to provide clearance for silencers.

Concealed metal reinforcements shall be provided for hardware in at least the following thicknesses:

Hinge reinforcement	10 gage
Strike reinforcement	14 gage
Closer reinforcement	12 gage
Other reinforcement	14 gage

2-4.04. Mullions and Transom Bars. Not used.

2-4.05. Reinforcing. Where structural steel members are indicated at mullions, transoms, or other locations, and are required to be built into hollow metal frames, the structural steel shapes shall be provided as part of the frame assembly.

2-4.06. Wall and Floor Anchors. Metal anchors of the sizes and shapes required for the adjoining type of wall construction shall be provided. Jamb anchors shall be fabricated from steel, of at least the same thickness as the frames. Anchors shall be located near the top and bottom of each frame and at intermediate points spaced not more than 32 inches apart.

For frames set in masonry, jamb anchors shall be at least 10 inches long, adjustable, and corrugated or other deformed type.

For frames set in metal stud partitions, anchors shall be welded to the backs of frames. Anchors shall be fastened to steel studs with 1/4 inch diameter machine bolts, or by welding.

For frames set in hardened concrete or existing masonry walls, anchorage shall be provided as indicated on the Drawings.

Door frames shall be provided with a 16 gage thick base clip at each jamb for floor anchorage. Clips shall be sized and drilled for at least two 3/8 inch diameter anchoring devices. Where floor fill occurs at a door opening, the bottom of the frame shall terminate at the indicated finished floor level and shall be supported by adjustable extension clip angles anchored to the structural slab.

2-4.07. Stops and Beads. Metal glazing beads shall be furnished with hollow metal frames at transoms, sidelights, interior glazed panels, and other locations where glazed frames are indicated on the Drawings. Glazing stops shall be formed as an integral part of the frames, and the frames shall be prepared to receive the glazing beads. Where frames are exposed to weather, the integral stops shall be located on the exterior side of the frames. Beads having a molded shape shall be mitered at corners. Rectangular beads may be either mitered or butted at corners.

2-5. DOORS. Doors indicated on the Drawings as hollow metal, including doors with glazed and louvered openings, shall be as specified herein. Doors shall be prepared to receive the hardware specified in the Finish Hardware section.

2-5.01. Workmanship. Doors shall be rigid, neat in appearance, and free from defects. Molded members for glazed doors shall be formed straight and true, with joints coped or mitered, well formed, and in true alignment. All welded joints on exposed surfaces shall be dressed smooth so that they are invisible after finishing.

2-5.02. Sizes and Clearances. Doors shall be of 1-3/4 inch thickness, and type indicated on the Drawings, of the sizes and design indicated. Clearances for doors, except fire doors, shall be 1/8 inch at jambs and heads, 1/4 inch at meeting stiles of pairs of doors, and 3/4 inch at bottom, unless otherwise indicated. Clearances for fire doors shall be as indicated by NFPA 80 or by the authority having jurisdiction.

2-5.03. Construction. Doors shall have 18 gage thick seamless outer sheets. Side edges of doors shall be flush and closed watertight. All seams shall be continuously welded and ground smooth. Doors shall be prepared at the factory for hardware, for glazing, and for louvers as indicated on the Drawings. Door edges shall be beveled or rounded.

Flush internally reinforced doors shall have fillers placed in the spaces between reinforcing members and shall be reinforced by 22 gage thick or thicker vertical steel stiffeners installed on 6 inch centers and welded to face sheets.

Flush foam-filled doors shall have all internal spaces completely filled with foamed-in-place polyurethane core or rigid urethane core chemically bonded to the interior surfaces of the door.

Outswinging exterior doors shall be finished flush at the top, with all seams and joints closed watertight as specified for side edges.

2-5.04. Hardware Provisions. Doors shall be mortised, reinforced, drilled, and tapped for mortised hardware. Reinforcing units shall be provided for locksets. Reinforcing plates shall be provided for mortised and surface-applied hardware in at least the following thicknesses:

Hinge reinforcement	10 gage
Surface-applied closers and hold-open arms	12 gage
Other reinforcement	14 gage

Where concealed overhead door closers are required, the necessary cutouts, reinforcement, and provisions for fasteners shall be made in the heads of doors.

The locations of hardware items shall be in accordance with DHI "Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames".

2-5.05. Stops and Beads. Metal glazing beads shall be furnished with hollow metal doors where glazed doors are indicated on the Drawings. Glazing stops may be formed as an integral part of the doors, or separate glazing beads provided for both sides of the glass. Doors shall be prepared to receive the glazing beads. Beads shall be snapped into place, or shall be fastened with oval-head machine screws spaced at 9 inch centers maximum. Beads having a molded shape shall be mitered at corners. Rectangular beads may be either mitered or butted at corners.

Where glazed doors are exposed to weather, all seams and joints on all sides of the glass panel, except joints in removable beads, shall be closed watertight as specified for side edges.

2-5.06. Astragals. The meeting edges of all exterior double doors, of interior double doors scheduled to be weatherstripped, and fire doors shall be provided with astragals. Fire doors shall be equipped with solid, bar type astragals. Astragals shall be applied to the active leaf unless otherwise indicated. When the astragal is attached to the inactive leaf, the active leaf shall be prepared for a lockset with a 3-3/4 inch backset.

2-5.07. Louvers. Not used.

2-6. FIRE DOORS AND FRAMES. Fire doors and frames shall be provided at the locations and of the ratings indicated on the Drawings. Doors and frames shall be labeled, constructed, and installed in accordance with the requirements of an Underwriters' Laboratories and shall have a maximum transmitted temperature end point of not more than 450°F above ambient at the end of 30 minutes of standard fire test exposure or a rating as indicated on the Drawings. Door of a corresponding classification by Factory Mutual or Warnock Hersey will be acceptable. For doors

exceeding the Underwriters' Laboratories size limitations for labeling, the UL "Certificate for Oversize Construction" shall be provided. Authorized construction details and requirements for labeling shall take precedence over these specifications, except when these specifications require a greater metal thickness.

2-7. SHOP FINISH. A primer shall be applied to all surfaces of ferrous metal furnished under this section. Metal surfaces shall be cleaned and given a phosphate or equivalent treatment to ensure maximum corrosion protection and paint adherence. A dip or spray coat of synthetic resin, rust-inhibitive metallic oxide, or rust-inhibitive zinc chromate primer shall be applied to all surfaces, then baked or oven-dried. Finished surfaces shall be smooth and free from irregularities.

PART 3 - EXECUTION

3-1. INSTALLATION. Frames shall be set in position, plumbed, aligned, and braced securely until permanent anchors are set. Frames shall be anchored to floors with expansion anchors or as indicated on the Drawings. Jamb anchors shall be built into walls and secured to adjoining construction. Spreader bars shall remain in place until frames have been built into the walls.

3-1.01. Transom Panels. Not used.

3-1.02. Glazing Beads. Glazing beads, when provided, shall be fastened to frames with oval-head machine screws spaced at 9 inch maximum centers.

End of Section

Section 08305

FLOOR ACCESS DOORS AND HATCHES

PART 1 - GENERAL

1-1. SCOPE. This section covers the fabrication and installation of cast-in-place, off-street, floor access doors and hatches. Manhole frames and covers are specified in the Sewer Manholes section.

Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Equipment shall be furnished complete with all components and accessories required for proper operation, and any additional materials or construction required by the manufacturer's design.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, together with detailed specifications, capacities, and data covering material used, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section.

For fire rated access doors and hatches, the manufacturer shall submit a test report certifying the specified performance.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-5. WARRANTY. The manufacturer shall guarantee against defects in material or workmanship for a warranty period of not less than 5 years.

PART 2 - PRODUCTS

2-1. GENERAL. Access doors and hatches shall be fabricated in conformity with dimensions, arrangements, sizes, and weights or thicknesses specified herein and as indicated on the Drawings.

All members and parts shall be free of warps, local deformations, and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. All field connection materials shall be furnished.

2-2. ACCEPTABLE MANUFACTURERS. Access doors and hatches shall be as manufacturerd by Halliday Products, Bilco Company, or Dur-Red Products.

2-3. DESIGN REQUIREMENTS. Door leaves shall be 1/4 inch [6 mm] minimum thickness plate material with pattern as indicated on the Drawings. Leaves in hatches not subject to vehicular loading shall be designed to withstand a minimum live load as indicated on the Drawings, with a maximum deflection of 1/150th of the span. Leaves shall pivot so that the cover does not protrude above the channel frame.

Door and hatch frames shall be provided with anchorage devices into the concrete slab. Where required for drainage, channel frames shall be 1/4 inch [6 mm] thick with a cross sectional area large enough to allow adequate water drainage. A 1-1/2 inch [38 mm] drainage coupling shall be located in the channel frame. The frame shall be designed to empty through the coupling. Frames shall have a neoprene door cushion unless a specific door model without a cushion is specified.

Hatches shall be supplied with lifting operators and hold-open devices. All doors, except fire rated doors, shall automatically lock in the vertical position by means of a hold-open arm with release handle. A snap lock with a gasketed cover plug and removable turn handle shall be provided. The operators shall provide for smooth, easy and controlled door operation throughout the entire arc of opening and closing. Operation shall not be affected by temperature.

Fall protection grating panels shall be provided on doors and hatches as indicated on the Drawings. The panels shall be aluminum or fiberglass grating panels designed to support a 300 psf loading. Panels shall be hinged along one edge and provided with a

positive latch to maintain unit in an upright position. Provision for locking the panel in place shall be provided. All hardware shall be of non-corroding material.

Odor resistant access doors and hatches shall be provided for all structures that are connected to the odor control system. Odor resistant doors and hatches shall be supplied with a continuous EPDM gasket to form an odor resistant barrier around the entire perimeter of the cover. The gasket shall provide the unit with an air infiltration rate of less than 1 cfm per linear foot [0.0015 m^3/s per linear meter] of cover perimeter while under a pressure differential, across the cover, of 1 inch [25 mm] water column. If the channel frame drainage system allows for the passage of odors into the frame, an appropriate drain trap will be provided to prevent odors from entering the connecting drainage system.

Fire rated access doors and hatches shall be UL listed for a 2 hour fire rating when exposed to fire from the underside. In the closed position, the temperature on the unexposed surface of the door assembly shall not exceed 325°F [162°C] during the 2 hour period. Fire rated door leaves shall have a fillable pan to receive concrete. They shall be provided with lifting operators and hold open devices as specified for other hatches. In addition, fire rated doors shall be equipped with a self-contained, pneumatic, automatic closing system which will close and latch the door leaves when the temperature exceeds 165°F [74°C].

2-4. MATERIALS. Floor access doors and hatches are indicated on the Drawings. Unless otherwise specified, materials, appurtenances, and finishes shall be the manufacturer's standard for each type of door and hatch indicated on the Drawings. Doors and hatches shall be odor resistant and/or fire rated only if specifically indicated on the Drawings.

If floor access doors and hatches are shown on the Drawings but not identified by manufacturer’s name and product number, Contractor shall request clarification from Engineer prior to ordering and shipping the equipment. For purposes of bidding the work, unidentified floor access doors and hatches shall be assumed to be aluminum with a drained channel frame, suitable for a live load of at least 150 psf [7.2 kPa].

2-5. FINISHES. Aluminum access doors and hatches shall be given a mill finish.

All aluminum surfaces in contact with concrete or mortar shall be given a heavy coat of epoxy enamel unless specified otherwise.

Steel doors shall be prime painted with manufacturer's standard primer or shall be hot-dip galvanized as indicated on the Drawings.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials shall be erected and installed in conformity with the dimensions and arrangements specified or indicated on the Drawings and as recommended by the manufacturer. Product finishes damaged during erection shall be repaired as recommended by the manufacturer. Hatch frames with drainage couplings shall be connected to the appropriate drainage system.

End of Section

SECTION 08330

OVERHEAD COILING SERVICE DOORS

PART 1 - GENERAL

1-1. SECTION INCLUDES. Advanced Performance Rolling Service Doors.

1-2. RELATED SECTIONS.

Section 05500 - Metal Fabrications: Support framing and framed opening.
Section 06200 - Finish Carpentry: Wood jamb and head trim.
Section 09900 - Painting: Field applied finish.
Section 16130 - Raceway and Boxes: Conduit from electric circuit to door operator and from door operator to control station.
Section 16150 - Wiring Connections: Power to disconnect.

1-3. REFERENCES.

NFRC 102 - Test Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.
ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Element.
ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
NEMA MG 1 - Motors and Generators.

1-4. DESIGN / PERFORMANCE REQUIREMENTS.

1-4.01. Overhead coiling insulated doors:

1. Wind Loads: Design door assembly to withstand wind/suction load of 20 psf (958 Pa) without damage to door or assembly components in conformance with ASTM E 330.

2. Operation: Design door assembly, including operator, to operate for not less than 20,000 cycles.

1-4.02. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

14.03. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified. Where indicated on the drawings, all equipment including but not limited to motors, control stations, and sensors shall be suitable for a Class 1 Division 2 area.

1-5. SUBMITTALS.

1-5.01. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Details of construction and fabrication.
4. Installation instructions.

1-5.02. Shop Drawings: Include detailed plans, elevations, details of framing members, anchoring methods, required clearances, hardware, and accessories. Include relationship with adjacent construction.

1-5.03. Motors: Motor submittals including motor and motor protection relay manufacturer’s catalog information, motor drawings with motor nameplate data and efficiency, speed range, and maximum starts per hour. Wiring diagrams shall show power and control wiring terminal connections.

1-6. QUALITY ASSURANCE.

1-6.01. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security closures.

1-6.02. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

1-7. <u>DELIVERY, STORAGE, AND HANDLING</u>. Store products in manufacturer's unopened packaging until ready for installation. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry. Store materials in a dry, warm, ventilated weathertight location.

1-8. PROJECT CONDITIONS. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1-9. COORDINATION. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

1-10. WARRANTY. Manufacturer's limited door and operator system, except the counterbalance spring and finish, to be free from defects in materials and workmanship for 3 years or 20,000 cycles, whichever occurs first.

PART 2 - PRODUCTS

2-1. MANUFACTURERS.

Acceptable Manufacturers:
Overhead Door Corp.
Clopay Corp.
Raynor Garage Doors
Wayne Dalton, Corp

2-2. INSULATED OVERHEAD COILING SERVICE DOORS.

2-2.01. Overhead Coiling Stormtite Advanced Performance Insulated Service Doors: Overhead Door Corporation Stormtite AP Model 627. (Design Standard)

2-2.02. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.

1. Flat profile type FIT-265 for doors up to 40 feet (12.19 m) wide.
2. Front slat fabricated of: 24 gauge galvanized steel.
3. Slat cavity filled with CFC-free foamed-in-place, polyurethane insulation. R-Value: 10.9, U-Value: 0.09.

2-2.03. Performance:

1. Through Curtain Sound Rating: STC-28 (STC-30+ with HZ noise generator) as per ASTM E 90.
2. Installed System Sound Rating: STC-21 as per ASTM E 90.
3. U-factor: 0.84 NFRC test report, maximum U-factor of no higher than 1.00.

2-2.04. Finish:

1. Galvanized Steel: Slats and hood galvanized in accordance with ASTM A 653 and receive rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester top coat.
2. Powder coat: PowderGuard Weathered Finish: Industrial textured powder coat provides a thicker, more scratch resistant coat. Applied to entire door system including slats, guides, bottom bar and head plate.
3. Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.

2-2.05. Weatherseals:

1. Vinyl bottom seal and internal hood seals.
2. Interior and exterior EPDM triple-seal finned guide weatherseal.

2-2.06. Bottom Bar: Two galvanized steel angles minimum thickness 1/8 inch (3 mm) bolted back to back to reinforce curtain in the guides.

2-2.06. Guides: Three structural steel angles.

1. Finish: PowderGuard Weathered finish with iron/black powder.
2. Brackets: Galvanized steel to support counterbalance, curtain and hood.

2-2.07. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.

2-2.08. Hood: Provide with internal hood baffle weatherseal. 24 gauge galvanized steel with intermediate supports as required.

2-2.09. Electric Motor Operation: Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second. Where indicated on the drawings, equipment installed in Class 1, Division 2 areas shall be suitable for use.

2-2.10. Sensing Edge Protection: electric sensing edge.

2-2.11. Operator Controls:

1. Push-button operated control stations with open, close, and stop buttons.
2. Controls for interior location.
3. Controls surface mounted.

2-2.12. Motor Voltage: 115 single phase, 60 Hz. Motor shall be suitable for Class 1 Division 2 area.

2-2.13. Windload Design: Standard windload shall be 20 PSF.

2-2.14. Locking: Chain keeper locks for chain hoist operation. Interior slide bolt lock for electric operation with interlock switch.

2-2.15. Wall Mounting Condition: Face-of-wall mounting. Provide with dual-wall polycarbonate.

PART 3 - EXECUTION

3-1. EXAMINATION. Verify opening sizes, tolerances and conditions are acceptable. Examine conditions of substrates, supports, and other conditions under which this work is to be performed. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3-2. PREPARATION. Clean surfaces thoroughly prior to installation.
Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3-3. INSTALLATION. Install in accordance with manufacturer's instructions. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress. Securely and rigidly brace components suspended from structure. Secure guides to structural members only. Fit and align assembly including hardware; level and plumb, to provide smooth operation. Complete wiring from disconnect to unit components. Install perimeter trim and closures. Instruct Owner’s personnel in proper operating procedures and maintenance schedule.

3-4. ADJUSTING. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion. Adjust hardware and operating assemblies for smooth and noiseless operation.

3-5. CLEANING. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer. Remove labels and visible markings. Touch-up, repair or replace damaged products before Substantial Completion.

3-6. PROTECTION. Protect installed products until completion of project.

End of Section

SECTION 08710

DOOR HARDWARE

PART 1 - GENERAL

1-1. RELATED DOCUMENTS. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY. Section includes: Mechanical door hardware. Related Sections: Section 08220 " FIBERGLASS (FRP) DOORS AND FRAMES

1-3. ACTION SUBMITTALS.

1-3.01. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

1-3.02. Samples for Verification: For exposed door hardware of each type required, in each finish specified, prepared on Samples of size indicated below. Tag Samples with full description for coordination with the door hardware schedule. Submit Samples before, or concurrent with, submission of door hardware schedule.

1-3.03. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1-3.04. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

1-3.05. Format: Use same scheduling sequence and as in the Contract Documents.

1-3.06. Content: Include the following information:

1. Identification number, location, hand, fire rating, size, and material of each door and frame.
2. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
3. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

4. Explanation of abbreviations, symbols, and codes contained in schedule.
5. Mounting locations for door hardware.
6. List of related door devices specified in other Sections for each door and frame.

1-3.07. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1-4. INFORMATIONAL SUBMITTALS.

1-4.01. Qualification Data: For Installer and Architectural Hardware Consultant.

1-4.02. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

1-4.03. Warranty: Special warranty specified in this Section.

1-5. CLOSEOUT SUBMITTALS.
Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

1-6. MAINTENANCE MATERIAL SUBMITTALS. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1-7. QUALITY ASSURANCE. Installer Qualifications, Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1-7.01. Scheduling Responsibility: Preparation of door hardware and keying schedules.

1-7.02. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows: For door hardware, an Architectural Hardware Consultant (AHC).

1-7.03. Source Limitations: Obtain each type of door hardware from a single manufacturer.

1-7.04. Keying Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." In addition to Owner**,** Construction Manager, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Requirements for key control system.
4. Requirements for access control.
5. Address for delivery of keys.
6. Review required testing, inspecting, and certifying procedures.

1-8. DELIVERY, STORAGE, AND HANDLING. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1-8. COORDINATION. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1-8.01. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

1-8.02. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1-10. WARRANTY.

1-10.01. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of doors and door hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

1-10.02. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

1-10.03. Cylinderical Locksets: Lifetime mechanical, three year finish, one year electrical from date of Substantial Completion.

1-11. MAINTENANCE SERVICE. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1-11.01. Maintenance Service: Beginning at Substantial Completion, provide **six** months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2-1. SCHEDULED DOOR HARDWARE. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

2-1.01. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products or[products equivalent in function and comparable in quality to named products complying with BHMA designations referenced.

2-1.02. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

2-1.03. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2-2. HINGES. BHMA A156.1. Provide template-produced hinges for hinges installed on FRP doors, frames.

2-2.01. Basis-of-Design Product: Subject to compliance with requirements, provide product by Stanley Commercial Hardware or comparable product by one of the following:

Hager Companies.
McKinney Products Company; an ASSA ABLOY Group company.

1. Equip with easily seated, non-rising pins.
2. Non Removable Pin screws shall be slotted stainless steel screws.
3. Hinges shall be full polished, front, back, and barrel.
4. Hinge pin is to be fully plated.
5. Sufficient size to allow 180-degree swing of door.
6. Furnish five knuckles
7. Provide hinge type as listed in schedule.
8. Furnish 3 hinges per leaf to 7 foot - 6 inch height. Add one to each additional 30 inches in height, or fraction thereof.
9. Tested and approved by BHMA for all applicable ANSI Standards for type, size, function, and finish.

2-3. LOCKING SYSTEMS

2-3.01. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

2-3.02. Bored Locks: Grade 1 minimum 1/2-inch latchbolt throw. Tested and approved by BHMA for ANSI A156.2, Series 4000, Operational Grade 1, Extra-Heavy Duty, and be UL/cUL Listed (3 hours). ANSI A117.1 Accessibility Code (ADA Compliant). Standard clutching mechanism for resistance for damage caused by physical force.

2-3.03. Intrconnected Levers: Grade 2 minimum 1/2 inch bolt throw. Tested and approved by BHMA for ANSI A156.2, 1999 Series 4000, Grade 2.

2-3.04. Auxiliary Deadbolts: Grade 1 minimum 1-inch bolt throw. Tested and approved by BHMA for ANSI A156.5, Operational Grade 1 1 inch throw deadbolt with hardened steel roller Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

2-3.05. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2-3.06. Basis-of-Design Product: Subject to compliance with requirements, provide product by K2 Commercial Hardware or comparable product by one of the following:

Arrow USA; an ASSA ABLOY Group company.
Best Access Systems; Div. of Stanley Security Solutions, Inc.
Corbin Russwin Architectural Hardware; n ASSA ABLOY Group Co.
SARGENT Manufacturing Company; an ASSA ABLOY Group company.
Schlage Commercial Lock Division; an Ingersoll-Rand company.

2-4. MANUAL FLUSH BOLTS. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

2-4.01. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

Adams Rite Manufacturing Co.; an ASSA ABLOY Group Co..
Burns Manufacturing Incorporated.
Don-Jo Mfg., Inc.
Door Controls International, Inc.
Hiawatha, Inc.
IVES Hardware; an Ingersoll-Rand company.
Trimco.

2-5. LOCK CYLINDERS. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

2-5.01. Basis-of-Design Product: Subject to compliance with requirements, provide product by K2 Commercial Hardware or comparable product by one of the following:

Arrow USA; an ASSA ABLOY Group company.
Best Access Systems; Div. of Stanley Security Solutions, Inc.
Corbin Russwin Architectural Hardware; an ASSA ABLOY Group Co.
SARGENT Manufacturing Company; an ASSA ABLOY Group Co.
Schlage Commercial Lock Division; an Ingersoll-Rand company.

2-5.02. Standard Lock Cylinders: BHMA A156.5; Grade 2.

2-5.03. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

2-6 KEYING.

2-6.01 Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

2-6.02. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.

2-6.03. Existing System: Master key or grand master key locks to Owner's existing system. Re-key Owner's existing master key system into new keying system.

2-6.04. Keys: Nickel silver

2-6.05. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

"DO NOT DUPLICATE."

2-6.06. Quantity: In addition to one extra key blank for each lock, provide the following:

Cylinder Change Keys: Three.
Master Keys: Five.
Grand Master Keys: Five.
Great-Grand Master Keys: Five.

2-7. KEY CONTROL SYSTEM.

2-7.01. Key Control Cabinet: BHMA A156.5; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.

2-7.02. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

American Key Boxes and Cabinets.
GE Security, Inc.
HPC, Inc.
Lund Equipment Co., Inc.
MMF Industries.
Tri Palm International.

2-7.03. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock. Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

GE Security, Inc.
HPC, Inc.
Knox Company.

2-7.04. Cross-Index System: Multiple-index system for recording key information. Include three receipt forms for each key-holding hook. Set up by Installer. Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Lund Equipment Co., Inc.
MMF Industries.
Tri Palm International.

2-8. ACCESSORIES FOR PAIRS OF DOORS.

2-8.01. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.

2-8.02. Astragals: BHMA A156.22.

2-9. SURFACE CLOSERS.

2-9.01. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2-9.02. Basis-of-Design Product: Subject to compliance with requirements, provide product by K2 Commercial Hardware or comparable product by one of the following:
Corbin Russwin Architectural Hardware; an ASSA ABLOY Group Co.
LCN Closers; an Ingersoll-Rand company.
Norton Door Controls; an ASSA ABLOY Group Co.

2-9.03. Description: Tested and approved by BHMA for ANSI 156.4, Grade 1 heavy duty or standard duty. UL10C and UL10B certified. Conforming to ANSI 117.1. Mount closers on non-public side of door, unless otherwise noted. Provide adapter plates, shim spacers, and blade stop spacers as required by frame and door conditions. Closers shall be non-handed, non-sized, and multi-sized.

2-10. DOOR GASKETING. BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

2-10.01. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
Hager Companies.
M-D Building Products, Inc.
National Guard Products.
Pemko Manufacturing Co.; an ASSA ABLOY Group Co.

Reese Enterprises, Inc.
Sealeze; a unit of Jason Incorporated.
Zero International.

2-11. THRESHOLDS. BHMA A156.21; fabricated to full width of opening indicated.

2-11.01. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Hager Companies.
M-D Building Products, Inc.
National Guard Products.
Pemko Manufacturing Co.; an ASSA ABLOY Group Co.
Reese Enterprises, Inc.
Rixson Specialty Door Controls; an ASSA ABLOY Group Co.
Sealeze; a unit of Jason Incorporated.
Zero International.

2-12. FABRICATION.

2-12.01. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

2-12.02. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted.

2-12.03. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

2-12.04. Machine Screws: For the following:

Strike plates to frames.
Closers to doors and frames.

2-12.05. Steel Through Bolts: For the following unless door blocking is provided:

Surface hinges to doors.
Closers to doors and frames.

2-13. FINISHES. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2-13.01. Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3-1. EXAMINATION. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3-2. PREPARATION. Swing doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3-3. INSTALLATION.

3-3.01. Mounting Heights: Mount door hardware units at heights unless otherwise indicated or required to comply with governing regulations. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

3-3.02. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

3-3.03. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

3-3.04. Lock Cylinders: Install construction cores to secure building and areas during construction period.

3-3.05. Furnish permanent cores to Owner for installation.

3-3.06. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

3-3.07. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

3-3.08. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

3-3.09. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

3-3.10. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3-4. FIELD QUALITY CONTROL. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3-5. ADJUSTING.

3-5.01. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3-5.02. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3-5.03. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3-6. CLEANING AND PROTECTION. Clean adjacent surfaces soiled by door hardware installation. Clean operating items as necessary to restore proper function and finish. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7. DOOR HARDWARE SCHEDULE.

'Set NO. 1, all single leaf hinged exterior doors
Butts 1 ½ pr 4-1/2 x 4-1/2, 626 Hager
Latchset 37HON3G626 Best
Closer 404QH LCN

Threshold 890 DKB Nat Guard
Weathrstrip 1 set S 182 Accurate
Silencers

Set NO. 2, all single leaf hinged interior doors
Butts 1 ½ pr 4-1/2 x 4-1/2, 626 Hager
Latchset 37HON3G626 Best
Closer 404QH LCN
Weathrstrip 1 set S 182 Accurate
Silencers

Set NO. 3, all double leaf hinged exterior doors
Butts 3 pr pr 4-1/2 x 4-1/2, 626 Hager
Latchset 35H7G14G12SH Best
Closer 404QH LCN
Top and Bottom dead bolts on inactive leaf
Coordinators: BHMA A156.3
Threshold 890 DKB Nat Guard
Weathrstrip 1 set S 182 Accurate
Silencers

Set NO. 4, all overhead coiling roll up doors
All weatherstrip and hardware by door manufacturer

End of Section

Section 09880

CORROSION PROTECTION LINING SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing and installation of corrosion protection systems to be applied to floors and curb at the chemical feed facility, and the Primary Clarifier Junction Box, as specified herein and as indicated on the Drawings. This section covers concrete surface preparation, furnishing and application of a corrosion protection system suitable for each set of specified service conditions, the engineering field services to be provided by the material manufacturer, and any appurtenances that are required to provide a completed corrosion protection system.

1-2. QUALITY ASSURANCE.

1-2.01. Manufacturer's Field Services. The applicator of the protection system shall contact the corrosion protection system material manufacturer during the bidding phase of the project and shall include in the cost of this work and the estimated cost of the manufacturers engineering field services as specified.

The field services provided by the material manufacturer shall include review of the project before surface preparation; approving the applicator, the materials, and the procedure to be used; observation and approval of the surface preparation; and observing the application. Where specified herein, the manufacturer shall also provide the adhesion testing to determine compliance with the specified minimum pull-off adhesion strength. The field representative of the protection system material manufacturer shall submit, through Contractor, written approvals of the proposed protection system materials, application procedures, applicator, and surface preparation. The field representative shall be an employee of the material manufacturer.

Contractor shall notify the material manufacturer and Engineer at least 10 days prior to anticipated date of placement of the protection system.

1-2.02. Applicator. The protection system applicator shall submit a satisfactory experience record including references for previous application of the specified protection system to concrete structures of similar design and complexity. The material manufacturer shall approve the applicator in writing.

1-3. SUBMITTALS. Complete specifications and data on the protection system, application instructions and procedures, and material manufacturer's approvals of the protection system furnished under this section shall be submitted in accordance with the Submittals Procedures section. The protection system manufacturer shall provide certification for each component of the protection system that will provide corrosion

resistance for the specified service conditions. The material manufacturer after application of the protection system shall certify that the protection system is free of pinholes and holidays.

1-4. DELIVERY, STORAGE, AND HANDLING. The material shall be delivered to the jobsite in original unopened containers with labels intact. Protection system components shall be stored indoors in an appropriate location and environment in accordance with the manufacturer's recommendations and shall be protected against freezing.

Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-5. WARRANTY. Material manufacturer shall warrant the chemical resistance of each corrosion protection system for a period of three years from the date of Substantial Completion when exposed to the customer's normal operating conditions as stated in the specification. This warranty shall not cover wear and tear such as abrasion resistance or mechanical abuse.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS.

2-1.01. General Service Conditions. The linings shall provide splash and spill protection for 72 hours from the chemicals as specified herein.

Surfaces to be coated are concrete .

2-2. MATERIALS. Materials shall be suitable for the specified service conditions. Products composing the corrosion protection system shall be chemically resistant to the chemicals, concentrations, temperatures, exposure times, and other relevant service conditions. In many cases, repair materials, primers, flexible basecoats, and other ancillary products that will be protected by a corrosion resistant and/or wear resistant layer of the protection system and may not be required to meet these criteria provided the overall protection system complies with the performance criteria. Each product of the protection system that complies with the performance requirements shall be certified as such by the protection system manufacturer. When recommended by the lining manufacturer, a vapor barrier shall be included as part of the corrosion protection system at no additional cost.

Each corrosion protection system specified is manufactured by Dudick, Inc. Acceptable alternative manufacturers that may have a corrosion protection system that will satisfy the specified service conditions and may be furnished subject to review and acceptance

by Engineer, are Carboline, Ceilcote/International Co., KCC Corrosion Control Co. Ltd, PolySpec Corporation, and Sherwin-Williams Control Tech Corrosion Protection Systems without exception. Other manufacturers and their corrosion protection systems will not be acceptable.

2-2.01. Epoxy Protection Systems. Not used.

2-2.02. Vinyl Ester Protection Systems. Not used.

2-2.03. Vinyl Ester With Graphite Filler Protection Systems.

2-2.03.01. Service Conditions for Vinyl Ester With Graphite Filler Protection Systems.

Chemicals to be contained at the maximum chemical temperature of 120°F , unless otherwise indicated, that are corrosive to concrete:

Ferric chloride; 45% conc.

Vinyl ester with graphite filler protection systems will be exposed to sunlight, UV, and outdoor atmosphere.

2-2.03.02. System requirements for Vinyl Ester With Graphite Filler Protection Systems.

Type of lining system.	Lining, mat reinforced with flexible basecoat.
Location(s) where a mat reinforced with flexible basecoat lining corrosion protection system is required:	Ferric chloride pump area inside the Chemical Building Interior of Primary Clarifier Junction Box

2-2.03.03. Vinyl Ester With Graphite Filler Coating System. Not used.

2-2.03.04. Vinyl Ester With Graphite Filler Rigid Lining System. Not used.

2-2.03.05. Vinyl Ester With Graphite Filler Flexible Lining System. The corrosion protection system shall be a two component, 100 percent solids, solvent-free, vinyl ester resin, graphite filled, mat reinforced flexible basecoat, high-build protective and waterproofing lining, Dudick "Protecto-Flex 805". Concrete surface primer shall be a epoxy resin containing conductive fillers, 100 percent solids, Dudick "Primer 67C". The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. Flexible basecoat with reinforcement shall be epoxy resin with silica fillers.

Reinforcement shall be chopped strand mat. Saturant for reinforcement shall be epoxy resin. Finish coats shall be a two component, 100 percent solids, solvent-free, graphite filled vinyl ester resin.

2-2.04. Novolac Vinyl Ester Protection Systems. Not used.

2-2.05. Novolac Epoxy Protection Systems. Not used.

2-2.06. Epoxy Filler Compound. Epoxy filler compound for concrete surfaces shall be a two-component, 100 percent solids epoxy filler or as recommended by the corrosion protection system material manufacturer.

2-2.07. Corrosion Resistant Caulking/Sealant. Chemical resistant caulking/sealant shall be suitable for the specified service conditions and shall be as recommended, in writing, by the protection system material manufacturer.

2-2.08 Reinforced Epoxy Resin Topping Systems. Not used.

2-2.09 Reinforced Vinyl Ester Resin Topping Systems. Not used.

2-2.10 Reinforced Vinyl Ester with Graphite Resin Topping Systems. The topping/lining shall provide abrasion resistance and splash and spill resistance for 72 hours at the ferric chloride metering pump area in the Chemical Building.

The corrosion protection system shall be a three component, 100 percent solids, vinyl ester resin, graphite filled, protective and waterproof topping with a heavy-duty reinforcement layer of synthetic fiber, Dudick "Protecto-Line 805". Concrete surface primer shall be a resin primer, 100 percent solids, Dudick "Primer 27C Conductive Primer". Concrete basecoat shall be Dudick "Protecto-Line 805 Basecoat". The topping corrosion protection system shall be certified by the material manufacturer as capable of at least 10 mils of differential movement without damaging the corrosion protection system.

2-2.11 Reinforced Novolac Vinyl Ester Resin Topping Systems. Not used.

2-2.12 Reinforced Novolac Epoxy Resin Topping Systems. Not used.

PART 3 - EXECUTION

3-1. GENERAL. All details, methods, and procedures of mixing, surface preparation, bonding, application, finishing, curing, and protection of the protection system shall be in strict accordance with the recommendations of the material manufacturer. The applicator shall comply with the recommendations of the material manufacturer's engineering field representative.

3-2. SURFACE PREPARATION. All surfaces shall be free of objectionable substances and shall meet the manufacturer's recommendations for surface preparation. If the lining material manufacturer recommends any other surface preparation, it shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

All surfaces shall be dry when coated or lined, and shall be free from dirt, dust, sand, mud, oil, grease, rust, mill scale, and other objectionable substances. Oil and grease shall be completely removed as recommended by the material manufacturer before mechanical cleaning is started.

3-2.01. Concrete Surfaces. Concrete surfaces shall be prepared in accordance with SSPC-SP13/NACE 6. Concrete surfaces shall be prepared until they are acceptable to the lining material manufacturer. Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film.

New concrete shall be cured for at least 28 days before lining is applied and shall be ready to receive the lining as determined by the material manufacturer. Concrete surfaces shall be tested for capillary moisture in the concrete in accordance with ASTM D4263. There shall be no capillary moisture migration after 24 hours as determined by the test method. If the manufacturer recommends using the calcium chloride test method to test for capillary moisture migration in the concrete and the test results exceed 3 pounds per 24 hours per 1,000 square feet or more stringent conditions recommended by the lining manufacturer, the corrosion protection system shall include a vapor barrier that is recommended by the protection system manufacturer.

Adhesion testing shall be conducted as specified herein after the concrete surface has been prepared and approved by the lining material manufacturer. Adhesion strength test results shall exceed 400 psi or a higher value if recommended by material manufacturer.

All concrete surfaces to be lined shall be cleaned in accordance with ASTM D4258 and abrasive blasted in accordance with ASTM D4259. Before the lining is applied, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. The Contractor shall repair all concrete surfaces that have spalls, voids, and cracks and shall remove all fins and other surface projections to produce a flush surface for application of the protection system.

Surface profile shall be at least 4 mils for a coating protection system and at least 22 mils for a lining protection system , but shall not be less than 25 percent of the dry film thickness specified for the corrosion protection system or 40-60 grit sandpaper unless recommended otherwise by the material manufacturer.

Concrete surfaces, including those with bug holes less than 1 inch in any dimension, shall be prepared using an epoxy concrete filler or as recommended by the material manufacturer and acceptable to Engineer.

3-2.02. Metal Surfaces. Not used.

3-3. MIXING AND THINNING. Materials shall be thoroughly mixed each time any is withdrawn from the container, and the containers shall be kept tightly closed except while the material is being withdrawn.

Protection system components shall be mixed to proper consistency and viscosity in accordance with the manufacturer's recommendations. Thinning will not be permitted. No adulterant, unauthorized thinner, or other material not included in the formulation, shall be added to the protection system components for any purpose

3-4. APPLICATION. Corrosion protection system shall be applied in accordance with the manufacturer's recommendations and in a neat manner, with finished surfaces free of runs, sags, ridges, laps, and brush marks. In no case shall the wet film thickness of applied protection system be less than the thickness recommended by the material manufacturer.

Grit shall be broadcast into first finish lining coat to produce an anti-skid surface.

Each coat shall be applied over the previous coat in accordance with the recommendations of the material manufacturer. Each coat shall be applied in a manner that will produce an even film of uniform and proper thickness. In no case shall coating be applied at a rate of coverage which is greater than the maximum rate recommended by the material manufacturer.

Recoating shall be applied in accordance with manufacturer's recommendations.

Alternate coats shall be of contrasting colors to facilitate in obtaining complete coverage. The first coat shall be a dark color.

Protection system showing checks, blisters, excessive sags, teardrops, or fat edges will not be acceptable and shall be entirely removed and the surface recoated. The protection system shall be free of pinholes and holidays.

Protection system shall be applied when surface temperature is at least 50°F and at least 5°F above dew point, and relative humidity is 85 percent or lower. Protection system shall not be applied in direct sunlight or when the temperature of the concrete is rising. Preferably the protection system shall be applied when the temperature of the concrete is dropping.

When applying high build protection system with a roller or brush and where a dry film thickness of at least 4 mils per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

3-4.01. Epoxy Protection Systems.

3-4.01.01. Epoxy Coating Protection System. Not used.

3-4.01.02. Epoxy Flexible Lining Protection System. Not used.

3-4.02. Vinyl Ester Protection Systems. Not used.

3-4.03. Vinyl Ester With Graphite Filler Protection Systems.

3-4.03.01. Vinyl Ester With Graphite Filler Coating System. Not used.

3-4.03.02. Vinyl Ester With Graphite Filler Rigid Lining System. Not used.

3-4.03.03. Vinyl Ester With Graphite Filler Flexible Lining System. The corrosion protection system shall be applied in four or more coats. The protection system shall consist of one prime coat, one basecoat, reinforcement and saturant, and two or more finish coats. The prime coat wet film thickness shall be at least 5 mils . The flexible basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 15-20 mils dry film thickness. The protection system shall have a total dry film thickness of at least 100 mils .

3-4.04. Novolac Vinyl Ester Protection Systems. Not used.

3-4.05. Novolac Epoxy Protection Systems. Not used.

3-4.06. Corrosion Resistant Caulking/Sealant. Corrosion resistant caulking/sealant shall be used at any penetration in the lining, such as at anchorage of pipe supports and chemical storage tanks.

3-4.07 Topping System. The reinforced EpoxyVinyl Ester with Graphite resin topping system shall be applied when surface temperature is 50^{o}F or higher and relative humidity is 90 percent or lower. Toppings shall not be applied in direct sunlight or when the temperature of the concrete is rising. Preferably the topping shall be applied when the temperature of the concrete is dropping.

3-4.07.01. Bonding. Topping shall be bonded to a clean, dry, and properly prepared concrete surface and that has been coated with a concrete primer that is acceptable to the topping manufacturer and Engineer.

3-4.07.02. Minimum Thickness. Topping shall have a minimum thickness of 1/8 inch .

3-4.07.03. Finish. Topping shall receive a uniform trowel finish.

3-5. FIELD QUALITY CONTROL. The surfaces shall be cleaned and prepared as needed to properly conduct the visual inspection, spark testing, and adhesion testing. All inspection and testing shall be witnessed by Engineer. Repairs shall be acceptable to Engineer.

3-5.01. Visual Inspection. The surface of the liner shall be visually inspected for areas showing poor adhesion, air inclusion, or other imperfections in the lining that prevent a complete seal of the surfaces.

3-5.02. Spark Testing. All detected holidays and pinholes shall be marked and repaired as recommended by the material manufacturer.

3-5.02.01. Concrete Surfaces. After the linings are applied, the material manufacturer shall spark-test all lined concrete surfaces using a high-voltage electrical spark tester in accordance with ASTM D4787 and set at the recommended voltage, or as a minimum at 100 volts per mil of liner thickness. Before beginning the spark testing the material manufacturer shall verify the testing equipment is working properly. The electrode movement shall be continuous and shall proceed in a systematic manner that will cover 100 percent of the lining surface. A carbon fiber brush shall be used on the sensor electrode.

3-5.02.02. Metal Surfaces. Not used.

3-5.03. Adhesion Testing. An adhesion test shall be conducted on all protection systems specified herein. Adhesion testing shall be conducted before application of the lining, on a properly prepared concrete surface that is acceptable to the material manufacturer and Engineer. The test area shall be at least 2 square feet to allow a minimum of three tests to be conducted. The test area shall be coated with the specified system and cured as recommended by the material manufacturer. Pull-off strength adhesion tests shall be conducted by the material manufacturer in accordance with ASTM D7234 for concrete surfaces using an Elcometer tensile adhesion tester. At least three adhesion tests shall be conducted and the results averaged. Adhesion strength shall equal or exceed the minimum adhesion strength recommended by the material manufacturer and shall exceed the tensile strength of the concrete.

If the lining fails the adhesion test, the cause of the failure shall be determined and corrected before the test is repeated.

3-6. PROTECTION. Care shall be taken to prevent coating from being dropped or spilled on adjacent surfaces, buildings, structures, or facilities. All surfaces so damaged shall be cleaned, repaired, replaced, or painted as acceptable to Engineer.

End of Section

SECTION 09900

PAINTING

PART 1 - GENERAL

1-1. SCOPE

A. This Section of the Specifications includes, but is not necessarily limited to, standards for cleaning and painting structures and equipment described in the Drawings and Specifications. Furnish all materials, equipment, and labor necessary to complete the Work.

Equipment and surfaces designated to be coated with heavy-duty maintenance coatings are specified under Section 09940. Corrosion protection lining systems for chemical areas are specified under Section 09880.

B. Section includes:

1. Surface preparation to receive finishes.
2. Priming and backpriming interior and exterior finish carpentry.
3. Painting, staining, or otherwise finishing of all surfaces.
4. Finishing millwork.

C. Related Work Specified Elsewhere

1. Section 03300, Cast-In-place Concrete.
2. Section 04200, Unit Masonry.
4. Section 05530, Grating.
5. Section 05990, Structural and Miscellaneous Metals.
6. Section 15050, Basic Mechanical Materials and Methods.

1-2. SUBSTITUTIONS

A. To the maximum extent possible, similar coatings shall be the products of one manufacturer. Guidelines for determination of acceptability of product substitutions are given in Instructions to Bidders. Contractors intending to furnish substitute materials or equipment are cautioned to read and comply strictly with these guidelines.

1-3. SUBMITTALS

A. All submittals and storage and protection provisions shall be in accordance with the requirements of the General Conditions, and the following.

1. Product data:

a. Submit complete list of products for use; indicate compliance with:
   1) Mercury-free composition limits.
   2) VOC limits, when mixed and thinned.
   3) Indicate lead content.

b. Indicate manufacturer, brand name, quality, and type paint for each surface to be finished; correlate to specified item if from other manufacturer than specified item. Refer to the attached sample Paint Submittal Schedule for required submittal format.

c. Include specified manufacturer's data sheets for reference to submitted manufacturer's data sheets.

d. Manufacturer's Safety Data Sheets (MSDS) for materials.

e. Intent of Contractor to use products specified does not relieve him from responsibility of submitting product line.

2. Samples:

   a. Color samples: Submit two sets of color samples from paint manufacturers proposed for use for color selections by Engineer.

   b. Brush-outs:

      1) Prepare actual brush-outs for each color paint, stain, or finish following final color schedule issuance.

      2) Submit brush-outs in duplicate: minimum size, 120 sq. in.

      3) Apply products in number of coats specified for actual Work.

      4) Provide following substrates for brush-outs:

         a) Concrete unit masonry: Paint one face to simulate concrete and masonry.

         b) Hardboard to simulate drywall, lumber, board products, and metals for paint finish.

         c) Actual species and grade of wood specified for transparent finish.

3. Quality control submittals:

   a. Certificates:

1) Indicate interior paints and stains are mercury-free.
2) Indicate lead content. Lead content in excess of 0.06% by weight of nonvolatile content calculated as lead metal is prohibited.
3) Indicate compliance with applicable VOC limits when mixed and thinned.

1-4. PROJECT MEETING

A. Prior to ordering any of the materials covered under this Section, the Contractor, Engineer, painting subcontractor, and paint manufacturer's representative shall attend a progress meeting in accordance with the General Conditions, and review the Work to be performed under this Section.

1-5. PAINTING REQUIREMENTS

A. Finish paint all exposed surfaces except anodized or lacquered aluminum, fiberglass reinforced plastic, stainless steel and copper surfaces. Items to be left unfinished or to receive other types of finishes are specifically shown on the Drawings or specified.

1. Unpainted Products: Full field cleaning and priming will be performed in accordance with specification requirements for unpainted products. Maintain adequate equipment on the site to assure proper cleaning.

2. Shop Primed Products:

a. Manufactured products may be shop cleaned and primed. Shop cleaning must equal or exceed cleaning specified in the Painting Schedule. Clean as specified and reprime all abrasions, weld splatter, excessive weathering, and other defects in the shop prime coating.

b. Manufacturers furnishing shop primed products shall certify that cleaning was performed in accordance with specification requirements and that the specified primer was used.

c. Fully field clean and prime any shop primed products which the Engineer determines that were not cleaned in accordance with the Specifications prior to priming, that the wrong primer was applied, that the primer was applied improperly, or has excessively weathered, or the product is otherwise unacceptable.

3. Finish Painted Products:
Certain products such as electrical control panels and similar items may, with the approval of the Engineer, be furnished finish painted. Properly protect these products throughout the project to maintain a bright and new appearance. If the finish surfaces are defaced, weathered, or not of the

selected color, repaint as necessary in accordance with the paint system manufacturer's written recommendations.

4. Hardware:
   Remove all electrical plates, surface hardware, fittings and fastenings prior to painting operations. These items are to be carefully stored, cleaned and replaced upon completion of Work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1-6. SEQUENCING AND SCHEDULING

A. Schedule and coordinate this Work with other trades; proceeding until other Work and job conditions are proper to achieve satisfactory results is prohibited.

B. Examine specification sections for various other trades; be thoroughly familiar with Work required in other sections regarding painting.

PART 2 - PRODUCTS

2-1. MATERIAL SCHEDULE

A. Material schedules list pretreatment coats, wash coats, seal coats, prime coats, intermediate coats, finish coats and cover coats that comprise a complete and compatible system of surface protection for the particular substrate. Maintain the unity of these systems, making sure all coats applied to any surface are from the same system and same manufacturer. Verify with the manufacturer the compatibility of the materials used.

2-2. APPLICATION DATA

A. All applicable data currently published by the paint manufacturer relating to surface preparation, coverages, film thickness, application technique, drying and overcoating times is included by reference as a part of this Section. It will be the responsibility of the Contractor to obtain and fully understand the appropriate data sheets for the coatings specified.

2-3. MATERIALS

A. Paints shall be factory mixed and delivered to the job in unbroken original packages bearing the manufacturer's name and brand designation and shall be applied in strict accordance with the manufacturer's printed specifications. Two-component coatings shall be mixed in accordance with manufacturer’s instructions. All two-component coatings, once mixed, shall be applied within the pot-life recommended by the manufacturer.

B. Unless otherwise specified, paints shall be of the best grade. All thinners,

driers, varnish, etc., shall be of the best grade and shall be furnished by the coating manufacturer for use with the specified paints.

C. Paint thinners and tints: Products of same manufacturer as paints or approved by paint manufacturer for use with paint.

D. Shellac, turpentine, patching compounds, and similar materials required for execution of Work: Pure, best quality products.

2-4. COLORS

A. New Buildings:

1. The Engineer will select the colors to be used on the various portions of the Work. Provide color cards for the coatings proposed. Where more than one coat of paint is required, job tint the paint for each undercoat off-shade to show complete coverage.

2. Paint inside of ductwork flat black for entire area visible through ceiling openings. Paint underside of ductwork and other above ceiling items flat black for entire area visible through ceiling openings.

3. Paint exposed pipes and ductwork same as adjacent ceiling surfaces.

PART 3 - EXECUTION

3-1. GENERAL

A. Adequately protect other surfaces from paint and damage. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Repair damage as a result of inadequate or unsuitable protection.

B. Protection: Cover finished Work of other trades, surfaces not being painted concurrently, and prefinished items.

C. Application of materials in spaces where dust is being generated is prohibited.

3-2. PRODUCT HANDLING

A. Delivery

1. Deliver materials in original, sealed containers of the manufacturer with labels legible and intact.

2. Each container shall be clearly marked or labeled to show paint identification, paint type and color, date of manufacture, batch number, analysis or contents, identification of all toxic substances, and special instructions.

B. Storage

1. Store only acceptable project materials on the project site.

2. Store material in a suitable location and in such a manner as to comply with all safety requirements including any applicable federal, state and local rules and requirements. Storage shall also be in accordance with the instructions of the paint manufacturer and the requirements of the insurance underwriters.

3. Restrict storage area to paint materials and related equipment.

4. Place any materials which may constitute a fire hazard in closed metal containers and remove daily from the project site.

5. Maintain neat, clean conditions in storage area; remove used rags from work areas at end of each day's work; store rags in closed containers.

6. Close containers at end of each day's Work. Leave no materials open.

7. Safety precautions:

a. Provide temporary fire protection equipment in materials storage area. Mark fire protection equipment location for quick access.

b. Prohibit smoking in storage area; post signs in visible location adjacent to and within storage area.

3-3. CLEANING AREA

A. Construct a temporary shed no smaller than 40 feet wide and 60 feet long for field cleaning, including blasting and priming operations. Maintain this area for all non-fixed painting operations until all such work has been completed and approved. Provide all fixtures and appurtenances required to perform the work including fixtures to support the work off the ground and proper storage facilities.

3-4. ENVIRONMENTAL CONDITIONS

A. Environmental conditions which affect coating application include, but are not necessarily limited to, ambient air temperature, surface temperature, humidity,

dew point and environmental cleanliness. Comply with the manufacturer's recommendations regarding environmental conditions under which coatings may be applied.

3-5. SURFACE PREPARATION

A. General: All surfaces shall be thoroughly clean, dry, and free from oil, grease or dust. All fabricated metal products shall have all weld flux and weld spatter removed and sharp peaks in weld ground smooth. The Engineer will inspect the surface preparation prior to the application of coatings. If the preparation is found to be satisfactory, a written order will be given to proceed with coatings.

B. Lumber, plywood, and veneered surfaces:

1. Apply shellac, maximum four lb. cut to knots, pitch, and resinous sapwood prior to application of first paint coat.

2. Surfaces to be painted: Fill nail holes, cracks, joints, and defects with spackling compound. Apply after first coat of paint.

3. Sand surfaces smooth, except where rough-sawn surfaces are indicated. Dust to remove debris.

4. Treat mildewed surfaces with solution of one quart hypochlorite bleach, one tablespoon laundry detergent, and three quarts water. Rinse and allow to dry prior to painting.

5. Previously painted surfaces: Remove dirt, debris, and chalking by washing with detergent and water or low pressure cold water spray. Dull glossy surfaces by light sanding. Remove loose paint and blisters by scraping and sanding.

C. Gypsum board:

1. Fill narrow, shallow cracks and small holes with patching plaster or non-shrinking spackling compound. Allow to dry; sand smooth without raising gypsum board paper nap.

2. Wall surfaces designated to receive semi-gloss or gloss finish: Roll apply batter consistency mixture of gypsum board joint compound and water to surfaces; remove immediately with wide broadknife, without leaving ridges or gouges in finished surface. Allow to dry prior to prime coat application, Or;
Apply U.S. Gypsum Company, Sheetrock First Coat at 300-500 SF per gallon in accord with manufacturer's installation instructions. Allow to dry prior to prime coat application.

D. Concrete Surfaces (not specified in other sections):

1. Fill cracks, holes, and irregularities with cement grout.

2. Remove laitance, oil, grease, dirt, and debris from surfaces. Verify concrete cure time prior to coating application.

3. For all concrete surfaces, the following surface preparation shall be employed:
   a. CC-I - Wash: Wash and scrub all surfaces with a solution of 1-1/2 ounces of soap chips and 1-1/2 ounces of trisodium phosphate in each gallon of water used. Flush away all soap and dirt with clean water. After this washing the surface will be rechecked and any rough areas not suitable for painting shall be sand blasted smooth.

3-6. APPLICATION

A. Conditions: No paint shall be applied upon damp or frosty surfaces, or in wet or foggy weather. No paint shall be applied In temperatures below 40^0 F. or when freezing (32^0 F.) is predicted within 24 hours of application, or under temperature or humidity conditions not recommended by the manufacturer.

B. Surface Preparation: After specified surface preparation, all surfaces shall be brushed free of dust or foreign matter. Surfaces shall be completely dry before any paint is applied.

1. Apply materials only when moisture content of surfaces is within manufacturer's recommended range.

C. Application: Paint shall be evenly spread in the proper thickness so that there shall be no drops, runs or sagging of the coating. Where runs and drops do occur, they shall be removed and the surface re-coated to the satisfaction of the Engineer. Sufficient time, as directed by the manufacturer, shall be allowed for the paint to dry before the application of succeeding coats.

1. Apply materials in accord with manufacturer's approved product data to achieve specified DFT.

2. Apply materials using clean brushes, rollers, or spray equipment. Limit paint spraying only to those materials recommended by manufacturer to be sprayed with no loss of performance, durability, or color.

3. Apply materials at rate not exceeding manufacturer's recommendations for surface being coated, less ten percent for losses.

4. Sand and dust between coats to remove defects visible from 5' - 0" distance. Tint primer and intermediate coats slightly to provide slight

contrast.

5. Finish coats: Smooth, free of brush marks, streaks, laps or pile-up of paint, skips, or missed areas.

6. Make coating edges adjoining other materials or colors sharp and clean without overlapping.

7. Primer coats may be omitted for surfaces specified to receive factory applied primer if finish coats are compatible with primer. Substitute bond coat recommended by paint manufacturer for specified primer coat if finish coats are not compatible.

8. Refinish entire partition surface where portion of finish on gypsum board partition is damaged or unacceptable.

9. Backprime exterior and interior finish carpentry and millwork with material specified for prime coat without runs on face; finish cut edges just prior to installation.

10. Seal interior doors' tops and bottoms of with prime coat only; side edges same as faces.

11. Finish exterior door edges same as exterior faces.

D. Protection of Work Area: Use drop cloths or other suitable means to protect other surfaces of the structure or equipment in place. Upon completion of the Work, remove all paint spots from surfaces as directed by the Engineer.

E. Inspection: The Engineer will inspect each coat prior to the application of subsequent coats. If the work is found to be satisfactory, a written order will be given to proceed. Application of additional coats until completed coat has been inspected is prohibited. Only inspected coats of paint will be counted in determining the number of coats applied.

F. Defective Work: Remove and replace, at the direction of the Engineer, any painting work found to be defective or applied under adverse conditions.

3-7. PAINTING SCHEDULE

A. Paint construction on roof top; include mechanical and electrical equipment except as indicated below.

1. Fume hood exhaust fan enclosures on roof.
2. Solvent Room exhaust fan.
3. HPLC Room exhaust fans.

B. Surfaces not requiring painting:

1. Face brick.
2. Precast concrete.
3. EIFS.
4. Prefinished surfaces and items.
5. Concealed ductwork, conduit, and piping.
6. Fume hood exhaust fan enclosures on roof.
7. Solvent Room exhaust fan on roof.
8. HPLC room exhaust fans on roof.

C. The Painting Schedule summarizes the painting systems to be applied to the various surfaces.

SAMPLE PAINT SUBMITTAL SCHEDULE

System	Specification	Item	Surface Preparation	Primer	Finish & Touch Up	Color
A	03300	Concrete Floors - Epoxy Floor Sealer	Blastrac or Muriatic Etch	76 Series, 4-6.0 mils	2 Coats of 76 Series, 4-6.0 mils	Gray
B	04200	Masonry Paint	SSPC 2 or 3 Pressure Washing to Remove Loose Concrete & Dirt	Block Fil 46-W-8,1 Coat	2 Coats of Valspar 76 Series at 4-6.0 mils per coat	Gray
C	08710	Door Slats	Mill Finish Aluminum	Not Required	Not Required	Not Required

PAINTING SCHEDULE

Surfaces	Substrate Materials	Paint Material/Schedule
Millwork Interiors	Wood	110
All Wood Surfaces, Except Millwork Interiors	Wood	Transparent Finish -112
Ceilings	Gypsum Board	122
	Exposed Concrete	131
Walls	Gypsum Board	Latex Low Luster Enamel - 121
	Gypsum Board	Epoxy - 122
	Concrete	131
	CMU Block	131
All Other Listed Metal Surfaces, Except Dumpsters	Galvanized Metal	141
	Ferrous Metal	141
Dumpsters, Exterior Surface	Ferrous Metal	240
Dumpsters, Interior Surface	Ferrous Metal	241
PVC Roof Drain Piping	Polyvinylchloride	150

MATERIAL SCHEDULE 110

TYPE: POLYURETHANE

USE: MILLWORK INTERIORS

SURFACE PREPARATION: PER SECTION 3.05.B

GLIDDEN

FIRST COAT: ULTRA-HIDE QUICK-DRYING SANDING SEALER NO. 5035 -1.1 MILS*

SECOND COAT: WOODMASTER CLEAR POLYURETHANE SATIN SHEEN NO. 82 - 1.3 MILS*

*MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 2.4 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. Benjamin Moore Company
   b. Devoe and Reynolds Company, Inc.
   c. Pratt and Lambert, Inc.
   d. PPG Industries, Inc.
   e. Sherwin-Williams Company

MATERIAL SCHEDULE 112

TYPE: POLYURETHANE

USE: TRANSPARENT FINISH ON WOOD

SURFACE PREPARATION: PER SECTION 3.05.B

GLIDDEN

FIRST COAT: WOODMASTER OIL WOOD STAIN, NO. 1600 SERIES

SECOND COAT: ULTRA-HIDE QUICK-DRYING SANDING SEALER NO. 5035 - 1.1 MILS*

THIRD COAT: WOODMASTER CLEAR POLYURETHANE GLOSS NO. 81 - 1.3 MILS*

FOURTH COAT: WOODMASTER CLEAR POLYURETHANE SATIN SHEEN NO. 82 -1.3 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 3.7 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Benjamin Moore Company
    b. Devoe and Reynolds Company, Inc.
    c. Pratt and Lambert, Inc.
    d. PPG Industries, Inc.
    e. Sherwin-Williams Company

MATERIAL SCHEDULE 121

TYPE: LOW LUSTER LATEX ENAMEL

USE: GYPSUM BOARD, AS SPECIFIED OR INDICATED ON DRAWINGS.

SURFACE PREPARATION: PER SECTION 3.05.C.

GLIDDEN

FIRST COAT: SPRED ULTRA EGGSHELL LATEX WALL & TRIM PAINT NO. 4100 SERIES - 1.6 MILS*

SECOND COAT: SPRED ULTRA EGGSHELL LATEX WALL & TRIM PAINT NO. 4100 SERIES - 1.6 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 3.2 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LISTS AND SAMPLES:

    a. Benjamin Moore Company.
    b. Devoe and Reynolds Company, Inc.
    c. Pratt and Lambert Inc.
    d. PPG Industries Inc.
    e. Sherwin-Williams Company.

MATERIAL SCHEDULE 122

TYPE: EPOXY

USE: WATERPROOF GYPSUM BOARD, AS SPECIFIED ON DRAWINGS

SURFACE PREPARATION: PER SECTION 3.05.C

AMERON

FIRST COAT: AMERLOCK 400 - 5.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 5.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. THESE PRODUCTS HAVE BEEN SELECTED TO ACHIEVE SPECIFIC RESULTS. NO SUBSTITUTIONS WILL BE ALLOWED.

MATERIAL SCHEDULE 131

TYPE: EPOXY

USE: INTERIOR MASONRY AND CONCRETE

SURFACE PREPARATION: CC-I

TNEMEC

FIRST COAT: EPOXY-POLYMIDE FILLER

SECOND COAT: SERIES 66 HI-BUILD EPOXOLINE - 4.0 MILS DRY

THIRD COAT: SERIES 66 HI-BUILD EPOXOLINE - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

KOPPERS

FIRST COAT: CONCRETE AND MASONRY FILLER

SECOND COAT: HI-GARD EPOXY - 4.0 MILS DRY

THIRD COAT: HI-GARD EPOXY - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Sherwin-Williams Company.

MATERIAL SCHEDULE 141

TYPE: HIGH BUILD EPOXY

USE: PROVIDE THE FOLLOWING COATING SYSTEM FOR FERROUS METAL SURFACES ON ALL MECHANICAL EQUIPMENT AND ACCESSORIES INCLUDING BUT NOT LIMITED TO: PUMPS, VALVING AND OTHER PROCESS EQUIPMENT AND EXTERIOR STRUCTURAL STEEL AND EXPOSED STEEL PIPE.

SURFACE PREPARATION: SSPC-SP10 NEAR WHITE BLAST-IMMERSION SERVICE

TNEMEC

FIRST COAT: SERIES 90-97 TNEME-ZINC 2.5-3.5 MILS DRY

SECOND COAT: SERIES 66 HI-BUILD EPOXOLINE 4.0-6.0 MILS DRY

THIRD COAT: SERIES 66 HI-BUILD EPOXOLINE 4.0-6.0 MILS DRY

* MINIMUM TOTAL DRY FILM THICKNESS 10.5 MILS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS IS NOT ACHIEVED IN THE NUMBER OF COATS SHOWN, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

a. Koppers.
b. Sherwin-Williams Company.

MATERIAL SCHEDULE 150

TYPE: ACRYLIC LATEX

USE: ALL PVC SURFACES TO BE PAINTED, AS SPECIFIED OR SHOWN ON DRAWINGS.

SURFACE PREPARATION: CLEAN AND DRY.

GLIDDEN

FIRST COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

SECOND COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 4.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Benjamin Moore Company.
    b. Devoe and Reynolds Company, Inc.
    c. Pratt and Lambert Inc.
    d. PPG Industries Inc.
    e. Sherwin-Williams.

MATERIAL SCHEDULE 240

TYPE: ALIPHATIC POLYURETHANE

USE: EXTERIOR OF SLUDGE HOPPER

SURFACE PREPARATION: SP-6

TNEMEC

FIRST COAT (SHOP PRIMER): SERIES 66-1211 EPOXOLINE PRIMER - 2.0 MILS DRY*

SECOND COAT (SHOP COAT): SERIES 66 HI-BUILD EPOXOLINE - 6.0 MILS DRY*

THIRD COAT: SERIES 70 ENDURA-SHIELD - 2.0 MILS DRY*

* MINIMUM 10.0 MILS DRY

KOPPERS

FIRST COAT (SHOP PRIMER): 654 EPOXY PRIMER - 2.0 MILS DRY*

SECOND COAT (SHOP COAT): HI-GARD - 6.0 MILS DRY*

THIRD COAT: 1122 BRS - 2.0 MILS DRY*

* MINIMUM 10.0 MILS DRY

NOTES:

1. IF MINIMUM DRY FILM THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN -ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Sherwin-Williams Company.
    b. Valspar.

MATERIAL SCHEDULE 241

TYPE: EPOXY

USE: INTERIOR OF SLUDGE HOPPER

SURFACE PREPARATION: SP-10

TNEMEC

FIRST COAT (SHOP PRIMER): SERIES 66-1211 EPOXOLINE PRIMER - 2.0 MILS DRY*

SECOND COAT (SHOP COAT): SERIES 66 HI-BUILD EPOXOLINE - 6.0 MILS DRY*
THIRD COAT: SERIES 104 HS EPOXY - 10.0 MILS DRY*

* MINIMUM 18.0 MILS DRY

KOPPERS

FIRST COAT (SHOP PRIMER): 654 EPOXY PRIMER 2.0 MILS DRY*

SECOND COAT (SHOP COAT): HI-GARD - 6.0 MILS DRY*

THIRD COAT: SUPER HIGH SOLIDS EPOXY - 10.0 MILS DRY*

* MINIMUM 18.0 MILS DRY

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

a. Sherwin- Williams Company.

End of Section

Section 09940

PROTECTIVE COATINGS

PART 1 - GENERAL

1-1. SCOPE. This section covers field applied protective coatings, including surface preparation, protection of surfaces, inspection, and other appurtenant work for equipment and surfaces designated to be coated with heavy-duty maintenance coatings. Regardless of the number of coats previously applied, at least two field coats in addition to any shop coats or field prime coats shall be applied to all surfaces unless otherwise specified.

1-2. GENERAL. Cleaning, surface preparation, coating application, and thickness shall be as specified herein and shall meet or exceed the coating manufacturer's recommendations. When the manufacturer's minimum recommendations exceed the specified requirements, Contractor shall comply with the manufacturer's minimum recommendations. When equivalent products are acceptable to Engineer, Contractor shall comply with this Specification and the coating manufacturer's recommendations.

1-2.01. Governing Standards. All cleaning, surface preparation, coating application, thickness, testing, and coating materials (where available) shall be in accordance with the referenced standards of the following AWWA, ANSI, NACE, SSPC, NSF, and ASTM.

1-2.02. Delivery and Storage. All coating products shall be received and stored in accordance with the coating manufacturer's recommendations.

1-2.03. Coatings, Painting, and Linings Covered in Other Sections. Not used.

Architectural painting.

Dampproofing of concrete when NSF compliance is not required.

Corrosion protection lining systems for secondary containment.

Elastomeric high solids urethane lining systems for corrosion protection and waterproofing.

Water repellant for masonry.

Elastomeric deck covering.

Steel tank coating.

1-3. SUBMITTALS. Contractor shall submit color cards for all coatings proposed for use, together with complete descriptive specifications, manufacturer's product data sheet and the completed Coating System Data Sheets, to Engineer for review and color

selection. Each product data sheet shall include application temperature limits including recoat time requirements for the ambient conditions at the site, including temperatures up to 130°F [54°C]. Requests for review submitted directly to Engineer by coating suppliers will not be considered.

When the proposed products will be in contact with treated or raw water in potable water treatment facilities, Contractor shall submit certifications that the proposed systems are in compliance with ANSI/NSF 61.

Contractor shall submit a Coating System Data Sheet for each separately identified surface in the Metal Surfaces Coating Schedule, Concrete and Masonry Surfaces Coating Schedule, and the Miscellaneous Surfaces Coating Schedule that will be used in the Project, using the appropriate Coating System Data Sheet forms (Figures 1-09940 and 2-09940) at the end of this section. Each field coating system shall be acceptable to the coating material manufacturer.

Coating System Data Sheets shall be assigned a unique number with a prefix letter based on the following:

Prefix	Surfaces	Fig.09940
A	Iron and steel (coated entirely in field)	1
A	Iron and steel (shop primed)	2
C	Concrete and concrete block	1
E	Equipment - submerged	1
E	Equipment – nonsubmerged	2
F	Nonferrous metal	1
G	Galvanized	1
H	High temperature	1
P	PVC and FRP	1

Each coating system that will be applied entirely in the field shall be assigned only a prefix letter and no suffix letter. Fig.1-09940 shall be submitted for each surface coated entirely in the field.

Each shop-applied coating system that includes one or more field applied coats shall be assigned both a prefix letter and suffix letter “F”. Fig.2-09940 shall be submitted for each surface having a shop applied coating and one or more field applied finish coats.

A separate Coating System Data Sheet shall be developed and submitted for each surface scheduled to be coated or variation or change in a coating system. The number identifying the surface and coating system shall be of the form $A1_1$ or $A1_2$-F. The subscript number shall be assigned by the Contractor so that each surface and coating system combination is uniquely identified. For example:

> $A1_1$-F may be assigned to "Epoxy – one coat to metal curbs for skylights and power roof ventilators that have been shop primed."
>
> $A2_1$ may be assigned to "Epoxy – two coats to non-galvanized structural and miscellaneous steel exposed to view inside buildings."
>
> $C2_1$ may be assigned to "Epoxy – two coats to all concrete and concrete block in corrosive area (Except floors and surfaces scheduled to receive other coatings) which are exposed to view."
>
> $C2_2$ may be assigned to "Epoxy – two coats to walls, floors, and curbed areas, adjacent to corrosive chemical storage and feed equipment as indicated on the Drawings."

The manufacturer's standard colors will be acceptable for all coatings.

1-4. QUALITY ASSURANCE.

1-4.01. Coating System Data Sheet Certifications. The coating applicator and coating manufacturer shall review and approve in writing the coating manufacturer's written recommendations for the coating system and the intended service. Any variations from the Specifications or the coating manufacturers published recommendations shall be submitted in writing and approved by the coating manufacturer. The coating manufacturer shall observe the surface preparation, mixing, and application of the coating systems and submit a written report of his observations and any additional recommendations.

1-4.02. Special Interior Coating Systems. Not used.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS.

2-1.01. Alternative Manufacturers. In addition to the coatings listed herein, equivalent products of other manufacturers that distribute globally will also be acceptable.

2-1.02. Equivalent Coatings. Whenever a coating is specified by the name of a proprietary product or of a particular manufacturer or vendor, it shall be understood as establishing the desired type and quality of coating. Other manufacturers' coatings will be accepted, provided that sufficient information is submitted to enable Engineer to

determine that the proposed coatings are equivalent to those named. Information on proposed coatings shall be submitted for review in accordance with the Submittals Procedures section. Requests for review of equivalency will be accepted only from Contractor, and will be considered only after the contract has been awarded.

2-2. MATERIALS. All coatings shall be delivered to the job in original, unopened containers, with labels intact. Coatings shall be stored indoors and shall be protected against freezing. No adulterant, unauthorized thinner, or other material not included in the coating formulation shall be added to the coating for any purpose.

All coatings shall conform to the air quality regulations applicable at the location of use. Coating materials that cannot be guaranteed by the manufacturer to conform, whether or not specified by product designation, shall not be used.

With the exception of heat resistant coatings, the coatings specified have been selected on the basis of the manufacturer's statement that the VOC content of the product is 2.8 lbs per gallon [335 g/L] or less; however, it shall be the Contractor's responsibility to use only coating materials that are in compliance with the requirements of all regulatory agencies. Local regulations may require some coatings to have a lower VOC content than specified herein. The coatings specified may meet the VOC limits in the unthinned (as shipped) condition, but may exceed the limits if thinned according to the manufacturer's recommendations. In such case, the coatings shall not be thinned beyond the 2.8 lbs per gallon [335 g/L] limit, and if the product cannot be thinned to suit the application method or temperature limits, another manufacturer's coating shall be used, subject to acceptance by Engineer.

Contractor shall be responsible for ensuring the compatibility of field coatings with each other or with any previously applied coatings. Coatings used in successive field coats shall be produced by the same manufacturer. The first field coat over shop coated or previously coated surfaces shall cause no wrinkling, lifting, or other damage to underlying coats.

All intermediate and finish coating materials that will be in contact with wastewater atmosphere shall be guaranteed by the manufacturer to be fumeproof and suitable for wastewater plant atmosphere that contains hydrogen sulfide. Coatings that cannot be so guaranteed shall not be used. Lead-free, chromium-free, and mercury-free coatings shall be used.

2-2.01 Primers.

Universal Primer (tie coat)	PPG Amercoat "Amercoat 385 Epoxy", Carboline "Rustbond", ICI Devoe "Devran 224HS", Tnemec "Series 27 F.C. Typoxy", or

	Sherwin-Williams "Dura Plate 235".
Zinc Primer	PPG Amercoat "Dimetate 9 Series", Carboline "Carbo Zinc II Series", ICI Devoe "Catha-Coat 304V", or Sherwin-Williams "Zinc Clad II Series".

2-2.02. Fillers and Surfacers.

Epoxy Concrete Block Filler	PPG Amercoat "Amerlock 400BF Epoxy Block Filler", Carboline "Sanitile 600", ICI Devoe "Truglaze 4015", Tnemec "Series 54-562", or Sherwin-Williams "Kem Cati-Coat HS".
Epoxy Concrete Filler and Surfacer	Tnemec "Series 218 MortarClad", PPG Amercoat "NuKlad 114A", Carboline "Carboguard 510", or Sherwin-Williams "Steel Seam FT910".

2-2.03. Intermediate and Finish Coatings.

Epoxy (NSF certified systems)

Ferrous Metal Surfaces and Concrete Surfaces in Contact with Treated or Raw Water in Potable Water Facilities	PPG Amercoat "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", ICI Devoe "Bar-Rust 233H" Tnemec "Series N140 Pota-Pox Plus", or Sherwin-Williams "Dura Plate 235 NSF"; immersion service.

Epoxy

Concrete Floors	PPG Amercoat "Amerlock 400", Carboline "Carboguard 890", ICI Devoe "Devran 224HS", Tnemec "Series N69 Hi-Build Epoxoline II", or Sherwin-Williams "Armorseal 1000HS"; nonskid.

Ferrous Metal Surfaces and Masonry or Concrete Surfaces Other Than Floors	PPG Amercoat "Amercoat 385 Epoxy", Carboline "Carboguard 890", ICI Devoe Devran "224HS", Tnemec "Series N69 Hi-Build Epoxoline II", or Sherwin-Williams "Dura Plate 235".
Fiber Reinforced Modified Polyamine Epoxy	Tnemec Series 436 Perma-Shield FR or equal
Flake-Filled Epoxy	Carboline "Plasite 4500/4500S", Sherwin-Williams "Sher-Glass FF", or equal.
Aliphatic Polyurethane	PPG Amercoat "Amercoat 450H", Carboline "Carbothane 134HG", ICI Devoe "Devthane 379H" Tnemec "Series 1074 Endura-Shield II", or Sherwin-Williams "Acrolon 218HS".
Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Medium Consistency Coal Tar	Carboline "Bitumastic 50" or Tnemec "46-465 H.B. Tnemecol".
Vinyl Ester	Tnemec "Series 120 Vinester" Carboline "Plasite 4110" or Sherwin-Williams "Magnalux 304FF".
Heat-Resistant	Suitable for temperatures up to 400°F [207°C]; PPG Amercoat "Amerlock 400", Carboline "Thermaline 450", Tnemec "43-36 Chrome Aluminum", or Sherwin-Williams "Silver-Brite Aluminum".
High Heat-Resistant	Suitable for temperatures up to 1000°F [537°C]; PPG Amercoat "Amercoat 878", Carboline "Thermaline 4700 VOC", or Sherwin-Williams "Silver-Brite Hi-Heat Silicone Aluminum".

PART 3 - EXECUTION

3-1. SURFACE PREPARATION. All surfaces to be coated shall be clean and dry and shall meet the recommendations of the coating manufacturer for surface preparation. Freshly coated surfaces shall be protected from dust and other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss on previously coated surfaces shall be dulled if necessary for proper adhesion of topcoats.

Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film, except for concrete block construction where a rough surface is an inherent characteristic.

When applying touchup coating or repairing previously coated surfaces, the surfaces to be coated shall be cleaned as recommended by the coating manufacturer, and the edges of the repaired area shall be feathered by sanding or wire brushing to produce a smooth transition that will not be noticeable after the coating is applied. All coatings made brittle or otherwise damaged by heat of welding shall be completely removed.

3-1.01. Galvanized Surfaces. Galvanized surfaces shall be prepared for coating according to the instructions of the manufacturer of the epoxy. Any chemical treatment of galvanized surfaces shall be followed by thorough rinsing with clean water.

3-1.02. Ferrous Metal Surfaces. Ungalvanized ferrous metal surfaces shall be prepared for coating by using one or more of the following cleaning procedures specified here-in: solvents (SSPC-SP1); abrasive blasting (SSPC-SP5, -SP10, -SP6, or -SP7) power tools (SSPC-SP3 or -SP11); or hand tools (SSPC-SP2). Oil and grease shall be completely removed in accordance with SSPC-SP1 before beginning any other cleaning method. Surfaces of welds shall be scraped and ground as necessary to remove all slag and weld spatter. Tools which produce excessive roughness shall not be used.

All components of equipment that can be properly prepared and coated after installation shall be installed prior to surface preparation. Components that will be inaccessible after installation shall have the surfaces prepared and coated before installation. Motors, drive trains, and bearings shall be protected during surface preparation in accordance with the equipment manufacturer's recommendations.

All cut or sheared edges shall be ground smooth to a 1/8 inch [3 mm] minimum radius for all material 1/4 inch [6 mm] thickness and larger. For material thickness less than 1/4 inch [6 mm] all cut or sheared edges shall be ground smooth to a radius equal to 1/2 the material thickness. Grinding of rolled edges on standard shapes with a minimum radius of the 1/16 inch [1.5 mm] will not be required.

All ferrous metal surfaces shall have all welds ground smooth and free of all defects in accordance with NACE Standard SP0178, Appendix C, Designation C and sharp edges ground smooth, if not previously prepared in the shop. Instead of blending of the weld with the base metal as required by the NACE standard, it will be acceptable to furnish a welded joint that has a smooth transition of the weld to the base metal. All welds shall be ground smooth to ensure satisfactory adhesion of paint.

The cleaning methods and surface profiles specified herein are minimums, and if the requirements printed in the coating manufacturer's data sheets exceed the limits specified, the value printed on the data sheets shall become the minimum requirement.

3-1.02.01. Ferrous Metal Surfaces – Non-immersion Service. Ferrous metal surfaces, including fabricated equipment, in non-immersion service shall be cleaned to the degree recommended by the coating manufacturer for surfaces to be coated with coal tar epoxy, epoxy, and heat-resistant coatings, except galvanized surfaces. Surface preparation of ferrous metal surfaces in non- immersion service shall consist of abrasive blast cleaning to SSPC-SP6, and the first application of coating shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Engineer. Surface profile shall be as recommended by coating manufacturer, but not less than 2.0 mils [50 µm].

3-1.02.02. Ferrous Metal Surfaces - Immersion Service. Surface preparation of ferrous metal surfaces in immersion service shall consist of abrasive blast cleaning to at least SSPC-SP10 and the first application of coating shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Engineer. Surface profile shall be as recommended by coating manufacturer, but not less than 3.5 mils [88 µm].

3-1.03. Concrete Surfaces. All concrete surfaces shall be free of objectionable substances and shall meet the coating manufacturer's recommendations for surface preparation. Concrete surfaces shall be prepared in accordance with SSPC-SP13/NACE 6. Provide a surface profile equal to ICRI CSP 5. Any other surface preparation recommended by the coating material manufacturer shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

All concrete surfaces shall be dry when coated and free from dirt, dust, sand, mud, oil, grease, and other objectionable substances. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started.

New concrete shall have cured for at least 4 weeks before coating is applied as recommended by the material manufacturer. Concrete surfaces shall be tested for capillary moisture in accordance with ASTM D4263. There shall be no capillary moisture when coatings are applied on concrete.

All surfaces to be coated shall be cleaned in accordance with ASTM D4258 and abraded in accordance with ASTM D4259. Surface profile shall be at least 25 percent of the dry film thickness specified for the coating system. Prior to application of the coating, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. Spalled areas, voids, and cracks shall be repaired in accordance with the Concrete section and as acceptable to the Engineer. Fins and other surface projections shall be removed to provide a flush surface before application of coating.

Except where epoxy is applied as damp-proofing, the concrete surfaces, including those with bug holes less than 1 inch [25 mm] in any dimension, shall be prepared as recommended by the manufacturer, using an epoxy concrete filler and surfacer. Where coating with a vinyl ester the concrete filler and surfacer shall be as recommended by the manufacturer to be compatible with vinyl ester.

3-1.04. Concrete Block Surfaces. Voids and openings in concrete block surfaces shall be pointed. All exposed exterior surfaces and surfaces to be coated with epoxy, including the joints, shall be filled so that a continuous unbroken coating film is obtained.

3-1.05. Copper Tubing. All flux residue shall be removed from joints in copper tubing. Immediately before coating is started, tubing shall be wiped with a clean rag soaked in xylol.

3-1.06. Plastic Surfaces. All wax and oil shall be removed from plastic surfaces that are to be coated, including PVC and FRP, by wiping with a solvent compatible with the specified coating.

3-1.07. Hardware. Hardware items such as bolts, screws, washers, springs, and grease fittings need not be cleaned prior to coating if there is no evidence of dirt, corrosion, or foreign material.

3-1.08. Aluminum. When a coating system is required, remove all oil or deleterious substance with neutral detergent or emulsion cleaner or blast lightly with fine abrasive.

3-1.09. Stainless Steel. When a coating system is required, surface preparation shall conform to the coating manufacturer's recommendations.

3-2. MIXING AND THINNING. Coating shall be thoroughly mixed each time any is withdrawn from the container. Coating containers shall be kept tightly closed except while coating is being withdrawn.

Coating shall be factory mixed to proper consistency and viscosity for hot weather application without thinning. Thinning will be permitted only as necessary to obtain recommended coverage at lower application temperatures. In no case shall the wet film thickness of applied coating be reduced, by addition of coating thinner or otherwise,

below the thickness recommended by the coating manufacturer. Thinning shall be done in compliance with all applicable air quality regulations.

3-3. APPLICATION. Coating shall be applied in a neat manner that will produce an even film of uniform and proper thickness, with finished surfaces free of runs, sags, ridges, laps, and brush marks. Each coat shall be thoroughly dry and hard before the next coat is applied. Each coat shall be a different color, if available. In no case shall coating be applied at a rate of coverage greater than the maximum rate recommended by the coating manufacturer.

Coating failures will not be accepted and shall be entirely removed down to the substrate and the surface recoated. Failures include but are not limited to sags, checking, cracking, teardrops, fat edges, fisheyes, or delamination.

3-3.01. Priming. Edges, corners, crevices, welds, and bolts shall be given a brush coat (stripe coat) of primer before application of the primer coat. The stripe coat shall be applied by a brush and worked in both directions. Special attention shall be given to filling all crevices with coating. When using zinc primers the stripe coat shall follow the initial prime coat.

Abraded and otherwise damaged portions of shop-applied coating shall be cleaned and recoated as recommended by the manufacturer of the finish coating. Welded seams and other uncoated surfaces, heads and nuts of field-installed bolts, and surfaces where coating has been damaged by heat shall be given a brush coat of the specified primer. Before the specified spot or touchup coating of metal surfaces, edges, corners, crevices, welds, and bolts in the area of the spot or touchup coating shall be given a brush coat of primer. This patch, spot, or touchup coating shall be completed, and the paint film shall be dry and hard, before additional coating is applied.

3-3.02. Epoxy. When used, epoxy shall be applied in accordance with the coating manufacturer's recommendations, including temperature limitations and protection from sunlight until top-coated.

When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

When applying high build epoxy coatings with a roller or brush and where a dry film thickness of at least 4-6 mils [100-150 µm] per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

3-3.03. Coal Tar Epoxy. When used, the application of coal tar epoxy, including time limits for recoating, shall conform to the recommendations of the coating manufacturer.

When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

3-3.04. Vinyl Ester. When used, the application of vinyl ester coating system, including time limits for recoating and temperature requirements of the materials, shall conform to the recommendations of the coating manufacturer.

3-3.05. Film Thickness. The total coating film thickness including intermediate coats and finish coat, shall be not less than the following:

Type of Coating	Minimum Dry Film Thickness
Medium consistency coal tar	20 mils [500 µm].
Coal tar epoxy (two coats)	20 mils [500 µm].
Epoxy	
Floors (two coats)	10 mils [250 µm].
Surfaces with first coat of epoxy and final coat of aliphatic polyurethane	7 mils [175 µm] (5 mils [125 µm] DFT for epoxy plus 2 mils [50 µm] DFT for aliphatic polyurethane).
Surfaces with first and second coat of epoxy and final coat of aliphatic polyurethane	12 mils [300 µm] (10 mils [250 µm] DFT for epoxy plus 2 mils [50 µm] DFT for aliphatic polyurethane).
Other surfaces (two coats)	10 mils [250 µm].
Immersion service (three coats)	15 mils [375 µm].
Concrete surfaces at the Headworks and Transfer Pump Station (Fiber Reinforced Modified Polyamine Epoxy)	110-125 mils [2,750-3,125 µm]
Flake-filled epoxy (two coats)	30 mils [750 µm].
Vinyl ester	30 mils [750 µm].
Zinc, epoxy, polyurethane	
Surfaces with first coat of zinc, intermediate coat of epoxy, and final coat of aliphatic polyurethane	10 mils [250 µm], 3 mils [75 µm] zinc, 5 mils [125 µm] epoxy, plus 2 mils [50 µm] for aliphatic polyurethane.
Heat-resistant (silicone)	3 mils [75 µm].
High heat-resistant (silicone)	3 mils [75 µm].
Other (one coat)	5 mils [125 µm].
Other (two coats)	10 mils [250 µm].

3-3.06. Weather Conditions. Coatings shall not be applied, except under shelter, during wet, damp, or foggy weather, or when windblown dust, dirt, debris, or insects will collect on freshly applied coating.

Coatings shall not be applied at temperatures lower than the minimum temperature recommended by the coating manufacturer, or to metal surfaces such as tanks or pipe containing cold water, regardless of the air temperature, when metal conditions are likely to cause condensation. When necessary for proper application, a temporary enclosure shall be erected and kept heated until the coating has fully cured.

Coatings shall not be applied at temperatures higher than the maximum temperature recommended by the coating manufacturer. Where coatings are applied during periods of elevated ambient temperatures, Contractor and the coatings manufacturer shall be jointly responsible to ensure that proper application is performed including adherence to all re-coat window requirements. Precautions shall be taken to reduce the temperature of the surface application, especially for metal, at elevated temperatures above 100°F [38°C] including shading application area from direct sunlight, applying coating in the evening or at night, and ventilating the area to reduce the humidity and temperature,

Vinyl ester coating materials, when required, shall be maintained during transportation, storage, mixing, and application at the temperature required by the coating manufacturer, 35°F [2°C] to 90°F [32°C].

3-4. REPAIRING FACTORY FINISHED SURFACES. Factory finished surfaces damaged prior to acceptance by Owner shall be spot primed and recoated with materials equivalent to the original coatings. If, in the opinion of Engineer, spot repair of the damaged area is not satisfactory, the entire surface or item shall be recoated.

3-5. PROTECTION OF SURFACES. Throughout the work Contractor shall use drop cloths, masking tape, and other suitable measures to protect adjacent surfaces. Contractor shall be responsible for correcting and repairing any damage resulting from its or its subcontractors' operations. Coatings spilled or spattered on adjacent surfaces which are not being coated at the time shall be immediately removed. Exposed concrete or masonry not specified to be coated which is damaged by coatings shall be either removed and rebuilt or, where authorized by Owner, coated with two coats of masonry coating.

3-6. FIELD QUALITY CONTROL. The following inspection and testing shall be performed: surface profile, visual inspection, and wet and dry film thickness testing. All inspection and testing shall be witnessed by Engineer.

3-6.01. Surface Profile Testing. The surface profile for ferrous metal surfaces shall be measured for compliance with the specified minimum profile. The surface profile for concrete shall comply with SSPC 13/NACE 6 Table 1 for severe service.

3-6.02. Visual Inspection. The surface of the protective coatings shall be visually inspected.

3.6.03. Film Thickness. Coating film thickness shall be verified by measuring the film thickness of each coat as it is applied and the dry film thickness of the entire system. Wet film thickness shall be measured with a gauge that will measure the wet film thickness within an accuracy of ±0.5 mil [12.5 µm]. Dry film thickness shall be measured in accordance with SSPC-PA 2.

3-6.04. Spark Testing. Not required.

3-6.05. Adhesion Testing. Not required.

3-7. FIELD PRIMING SCHEDULE. In general, steel and cast iron surfaces of equipment are specified to be shop primed. Any such surfaces which have not been shop primed shall be field primed. Damaged or failed shop coatings which have been determined unsuitable by Engineer shall be removed and the surfaces shall be field coated, including prime coat (if any). Galvanized, aluminum, stainless steel, and insulated surfaces shall be field primed. Primers used for field priming, unless otherwise required for repair of shop primers, shall be:

Surface To Be Primed	Material
Equipment, surfaces to be coated with	
Aliphatic polyurethane	Universal primer.
Epoxy	Same as finish coats.
Coal tar coating	Same as finish coats.
Vinyl ester	Same as finish coats.
Steel and cast iron, surfaces to be coated with	
Epoxy	Same as finish coats or inorganic zinc.
Coal tar coating	Same as finish coats.
Aluminum	Epoxy.
Galvanized	Epoxy.
Copper	Epoxy.
Stainless steel	Epoxy.
Plastic surfaces, including PVC and FRP	Same as finish coats.
Insulated piping	As recommended by manufacturer of finish coats.
Concrete, surfaces to be coated with epoxy	
For damp-proofing	Epoxy.
For all other surfaces	Epoxy concrete filler and surfacer.
Concrete block exposed in exterior locations	Epoxy concrete block filler.

Surface To Be Primed	Material
Concrete block to be coated with epoxy	Epoxy concrete block filler.

Unless otherwise recommended by the coating manufacturer or specified herein, priming will not be required on concrete, or concrete block, nor on metal surfaces specified to be coated with coal tar epoxy, and heat-resistant coatings. Concrete surfaces to be coated with epoxy shall be filled with epoxy concrete filler and surfacer so that a continuous film is obtained, except where concrete is damp-proofed with epoxy.

3-8. FINISH COATING SYSTEMS. The following schedule lists coatings systems and coating surface designations. See Article1-3 for a definition of the surface designations.

No.	Finish Coating Systems	Coating Surface Designation						
		A	C	E	F	G	H	P
1.	Epoxy – One coat	**x**			**x**	**x**		
2.	Epoxy – Two coats	**x**	**x**	**x**	**x**	**x**		**x**
3.	Epoxy / NSF – Two coats		**x**	**x**				
4.	Epoxy – Three coats	**x**	**x**	**x**				
4a	Fiber Reinforced Modified Polyamide Epoxy		**x**					
5.	Epoxy / NSF – Three coats	**x**	**x**	**x**				
6.	Epoxy – First coat Aliphatic polyurethane – Finish coat	**x**	**x**	**x**	**x**	**x**		**x**
7.	Epoxy – First and second coat Aliphatic polyurethane – Finish coat	**x**	**x**	**x**	**x**	**x**		
8.	Universal primer – First coat Aliphatic polyurethane – Finish coat	**x**		**x**				
9.	Medium consistency coal tar – Two coats	**x**	**x**	**x**				
10.	Coal tar epoxy – Two coats	**x**	**x**	**x**				
11.	Vinyl ester – Two coats	**x**	**x**	**x**				
12.	Heat resistant – Two coats						**x**	
13.	High heat resistant – Two coats						**x**	

No.	Finish Coating Systems	Coating Surface Designation						
		A	C	E	F	G	H	P
14.	Zinc primer – First coat Epoxy – Intermediate coat Aliphatic polyurethane – Final coat	**x**		**x**				
15.	Flake-filled epoxy	**x**		**x**				

3-8.01. Surfaces Not To Be Coated. Unless otherwise specified, the following surfaces shall be left uncoated:

Exposed aluminum, except ductwork.
Polished or finished stainless steel. Unfinished stainless steel, except flashings and counter flashings, shall be coated.
Nickel or chromium.
Galvanized surfaces, except piping, conduit, ductwork, and other items specifically noted.
Rubber and plastics, except as specified.
Exterior concrete.
FRP wastewater troughs.
Surfaces specified to be factory finished.

3-8.02. Shop Finishing. Items to be shop finished include the following. Shop finishing shall be in accordance with the coating manufacturer's recommendations.

a. All slide gates.
b. All conveyors.
c. Other surfaces where blast cleaning cannot be or is not recommended to be performed in the field.
d. Other items as otherwise specified.

3-8.03. Field Coating. Items to be field coated include the following. Field coating shall be in accordance with the field priming schedule, the coating schedule, and the manufacturer's recommendations.

a. Exterior surface of the sludge hopper.
b. Surfaces not indicated to be shop finished and surfaces where blast cleaning can be performed in the field.
c. All interior ferrous metal surfaces except stainless steel on the digester cover.
d. Other items as otherwise specified.

3-9. METAL SURFACES COATING SCHEDULE.

Surface To Be Coated	Finish Coating System
Non-galvanized and galvanized structural and miscellaneous steel exposed to view or to the elements in exterior locations.	A6,A7 ,A14
Non-galvanized and galvanized structural and miscellaneous steel exposed to view inside buildings.	A2
Steel handrails, steel floor plates, doors, door frames .	A8
Unless otherwise specified, pumps, motors, speed reducers, and other machines and equipment exposed to view.	E8
Actuator surfaces for sluice gates, slide gates, control weirs, unless factory finished.	Outdoor – E7E8 , Indoor – E6E8
Digester covers, all iron and steel parts that will be exposed to view.	E7
Metal curbs for skylights and power roof ventilators.	A1
Heating and air conditioning units, convector covers, electrical equipment cabinets, and similar Items and equipment (unless factory finished) exposed to view.	E8
Surfaces of cranes and hoists exposed to view indoors.	E2, E8
Surfaces of cranes and hoists exposed to the elements outdoors.	E6, E7
Dockboard and metal parts of dock bumpers exposed to view or to the elements.	E8
Steel yard lighting poles exposed to view or to the elements.	A8

Surface To Be Coated	Finish Coating System
Cast Iron and steel piping inside buildings, including piping to be insulated, valves, fittings, flanges, bolts, supports, and accessories, and galvanized surfaces after proper priming.	A2
Cast Iron and steel piping in immersion service including inside buildings, including valves, fittings, flanges, bolts, supports, and accessories, and galvanized surfaces after proper priming.	A4, A5
Cast Iron and steel piping above grade exposed to the elements and to view outdoors, including piping to be insulated, valves, fittings, flanges, bolts, supports, and accessories, and galvanized surfaces after proper priming.	A6, A7 , A14
Copper pipe and tubing, including fittings and valves.	F1, F2
Copper pipe and tubing, including fittings and valves exposed to view in exterior locations.	F6, F7
Circular sludge collecting equipment and accessories, all Iron and steel parts except platform, walkway, walkway beams, motors and speed reducers, and other iron or steel parts above the walkway.	E4, E5, E15
Circular sludge collecting equipment platform, walkway, walkway beams, and other iron or steel parts and accessories above the walkway except motors and speed reducers.	E6, E7
Basin launders, troughs, weir plates, and accessories.	A4, A5
Rapid mix equipment, all Iron and steel surfaces except stainless steel, motors, and speed reducers.	E4, E5

Surface To Be Coated	Finish Coating System
All metal surfaces, unless otherwise specified, which will be submerged or buried, all or in part, including valves, and scum baffles, and cast iron slide gates, but excluding piping laid in the ground.	E4, A10, E5
All fully or partially submerged surfaces of screening, grit removal, aeration mixing, and sludge mixing equipment.	E4, A10, E5
Sludge inlet hoppers lining.	E10
Miscellaneous castings, including manhole rings and covers, and manhole steps. (One coat, if not shop coated.)	E2, A10, E3
Cast iron and steel piping in manholes, wetwells, grit basin, aeration basin, and similar locations, including valves fittings, flanges, bolts, supports, and accessories.	A4, A10, E5
All metal harness anchorage for buried piping.	A10
Digester covers, all iron and steel parts that will be fully or partially submerged, exposed to sewage gas, or concealed inside; and digester mixing equipment.	E10, E11
Exterior surfaces of extension hoppers and accessories for chemical feeders.	Outdoor – E6, Outdoor – E7 Indoor – E2
Exterior surfaces of carbon steel chemical tanks.	Outdoor – A6, Outdoor – A7 Indoor – A1
Supports and miscellaneous metal for equipment handling corrosive chemicals.	Outdoor – A6, Outdoor – A7 Indoor – A2
Aluminum in contact with concrete.	F1
Vacuum pump discharge piping.	H12
Engine exhaust piping.	H12
Aluminum and galvanized ductwork and conduit indoors.	F1 or G1F2 or G2

Surface To Be Coated	Finish Coating System
Aluminum and galvanized ductwork and conduit exposed to elements outdoors.	F6 or G6F7 or G7
Aluminum materials exposed to the elements outdoors.	F6, F7
Tilting weirs.	E4

3-10. CONCRETE AND MASONRY SURFACES COATING SCHEDULE.

Surface To Be Coated	Finish Coating System
All concrete and concrete block in corrosive area (Except floors and surfaces scheduled to receive other coatings) which are exposed to view.	Indoor –C2 Outdoor –C7
Interior surfaces of sludge drawoff boxes.	C10
Where indicated on the Drawings, walls, floors, and curbed areas, adjacent to corrosive chemical storage and feed equipment.	C2
All walls in contact with liquid where the opposite face forms a part of an interior room or dry pit.	C4, C5
Interior of wastewater manholes, diversion structure, and primary clarifier effluent junction structure.	C10
All surfaces in the Transfer Pump Station wet well, including the concrete walls, baffle walls, wet well floor and pump room underslab.	C4a
All surfaces inside the Headwork structure concrete channels, including channel walls, concrete fillets, and floors,	C4a

3-11. MISCELLANEOUS SURFACES COATING SCHEDULE.

Plastic Surfaces, including PVC and FRP.	Outdoor – P6 Indoor – P2

Piping Insulation	Outdoor – P6 Indoor – P2

3-12. PIPING IDENTIFICATION SCHEDULE. Exposed piping and piping in accessible chases shall be identified with lettering or tags designating the service of each piping system, marked with flow directional arrows, and color coded.

Piping scheduled to be color coded shall be completely coated with the indicated colors, except surfaces specified to remain uncoated shall include sufficiently long segments of the specified color to accommodate the lettering and arrows. All other piping shall be coated to match adjacent surfaces, unless otherwise directed by Engineer.

3-12.01. Location. Lettering and flow direction arrows shall be provided on pipe near the equipment served, adjacent to valves, on both sides of wall and floor penetrations, at each branch or tee, and at least every 50 feet [15 m] in straight runs of pipe. If, in the opinion of Engineer, this requirement will result in an excessive number of labels or arrows, the number required shall be reduced as directed.

3-12.02. Metal Tags. Where the outside diameter of pipe or pipe covering is 5/8 inch [15 mm] or smaller, aluminum or stainless steel tags shall be provided instead of lettering. Tags shall be stamped as specified and shall be fastened to the pipe with suitable chains. Pipe identified with tags shall be color coded as specified.

3-12.03. Lettering. Lettering shall be painted or stenciled on piping or shall be applied as snap-on markers. Snap-on markers shall be plastic sleeves, Brady "Bradysnap-On B-915", Seton "Setmark", or equal. Letter size shall be as follows:

Outside Diameter of Pipe or Covering	Minimum Height of Letters
5/8 inch [15 mm] and smaller	Metal tags -1/4 inch [6 mm]
3/4 to 4 inches [20 to 100 mm]	3/4 inch [20 mm]
5 inches [125 mm] and larger	2 inches [50 mm]

3-12.04. Color Coding and Lettering. All piping for the following services shall be color coded. Bands shall be 6 inches [150 mm] wide spaced along the pipe at 5 foot [1.5 m] intervals. For services not listed, the color coding and lettering shall be as directed by the Engineer.

Piping Identification		
Service	**Color of Pipe**	**Color of Letters**

Piping Identification		
Service	**Color of Pipe**	**Color of Letters**
Chilled Water (supply or return)	Dark blue with red bands	White
Compressed Air	Dark green	Black
Condensate	Light gray with brown bands	Black
Condenser Water (supply or return)	Dark blue with white bands	White
Drain	Dark gray	White
Ferric Chloride	Orange	Black
Fire Protection Water	Red	White
Fuel Oil	Black	White
Gasoline	Black with red bands	White
Grease	Black with yellow bands	White
Grey Water	Purple	Black[1]
Grit	Light grey with black bands	White
Heating Water (supply or return)	Light gray with black bands	Black
Instrument Air	Light green with dark green bands	Black
Natural Gas Or Propane Gas	Yellow with red bands	Black
Nonpotable Water (downstream of backflow preventer)	Purple	Black[2]
Odor Control – Indoors	Dark green with light brown bands	White
Odor Control – Outdoors	White	Black
Oil – Hydraulic	Black with white bands	White
Plant Effluent Water	Purple	Black[3]
Plumbing Vents	Dark gray	White
Polymer	Orange with green bands	Black

Piping Identification		
Service	**Color of Pipe**	**Color of Letters**
Potable Water (hot or cold)	Dark blue	White[4]
Refrigerant	Yellow with white bands	Black
Sample	Light gray with green bands	Black
Scum	Dark brown	White
Service Water	Dark blue with red bands	White
Settled Sewage	Light gray with brown bands	Black
Settled Sewage Service Water	Dark blue with orange bands	White
Sewage	Dark gray	Black
Sludge	Dark brown	White

Notes:

1. Lettering shall read, “CAUTION: NONPOTABLE WATER, DO NOT DRINK.”.
2. Lettering shall be on a yellow background and shall read, “CAUTION: NONPOTABLE WATER, DO NOT DRINK.”. Each outlet on the nonpotable water line shall be similarly labeled.
3. Lettering shall read, “CAUTION: RECLAIMED WATER, DO NOT DRINK”.
4. Lettering shall be on a light green background.

Electrical conduit shall be coated to match adjacent ceiling or wall surfaces as directed by Engineer. Vent lines shall be coated to match surfaces they adjoin.

In addition, special coating of the following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes

Numerals at least 2 inches [50 mm] high shall be painted on or adjacent to all accessible valves, pumps, flowmeters, and other items of equipment which are identified on the Drawings or in the Specifications by number.

End of Section

SURFACE DESCRIPTION	SYSTEM NO. -

SURFACE PREPARATION DESCRIPTION

- ☐ Solvent SSPC-SP1
- ☐ Ferrous Metal Nonimmersion SSPC-SP6
- ☐ Ferrous Metal Immersion
  - ☐ SSPC-SP10
  - ☐ SSPC-SP-5
- ☐ Other

COATING	DFT mils [µm]	MANUFACTURER AND PRODUCT
First Coat (Primer)		
Second Coat		
Third Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:		
Coatings Manufacturer:		Initials _____
Painting Applicator:		Initials _____
BLACK & VEATCH	COATING SYSTEM DATA SHEET	Fig 1-09940

SHOP PRIMED SURFACE DESCRIPTION	SYSTEM NO. -	-F

SURFACE PREPARATION DESCRIPTION
☐ Solvent SSPC-SP1 ☐ Other:

COATING	DFT mils [µm]	MANUFACTURER AND PRODUCT
Shop (Primer)		(Identify Product/Type)
Touchup		
Intermediate Coat		
Finish Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:		
Coatings Manufacturer:		Initials _____
Painting Applicator:		Initials _____
BLACK & VEATCH	COATING SYSTEM DATA SHEET	Fig 2-09940

SECTION 10440

IDENTIFYING DEVICES

PART 1 - GENERAL

1-1 DESCRIPTION. The Contractor shall furnish all the materials for and shall properly erect and install all identifying devices at the locations shown and as indicated on the Drawings, and as specified herein.

This shall include all identification signs and warning signs, including supports, fastening devices, and accessories, and all labor, materials, tools, and appurtenances required to complete the Work.

It is the intent of this Specification that the installation shall be complete in all respects and ready for use. The Contractor shall be responsible for all incidental details and for any special construction necessary to complete the work in an acceptable manner.

Related Work Specified Elsewhere:

1. Section 10990, Miscellaneous Building Specialties.
2. Section 15440, Emergency Shower and Eyewash Fixtures.
3. Section 15060, Piping and Appurtenances.

1-2 SUBMITTALS: Product Data: Submit manufacturer's technical data and installation instructions for each type of sign required.

Samples: Submit samples of each sign form and materials showing finished, colors, surface textures and qualities of manufacturer and design of each sign component including graphics.

1-3 QUALITY ASSURANCE: Uniformity of manufacturer: For each sign form and graphic image process indicated furnish products of single manufacturer.

Quality of signage shall be not less than ASI-SPE construction.

PART 2 - PRODUCTS

2-1 MATERIALS.

2-1.01. General: Identifying devices shall be of the type and materials specified for each category. Unless otherwise indicated, signs shall be the manufacturer's stock items.

2-1.02. Life Safety Signs: Signs shall be butyrate with red lettering on white background, and conforming to OSHA regulations. Sign denoting fire extinguisher location shall be vinyl with pressure-sensitive adhesive backing.

1. NO SMOKING: Located at all entrance doors.
2. FIRE EXTINGUISHER: Located above all extinguishers.
3. DANGER - DO NOT DRINK THIS WATER: Located at each water station.
4. DANGER - CONFINED SPACE ENTRY- ENTER BY PERMIT ONLY: Mounted on west wall above the stairs to air discharge channel. (White background, red and black letters, 14" x 20").

2-1.03. Interior and Directional Signs: Signs shall be ASI/2 type A, constructed of 0.015-inch vinyl laminated to 1/4-inch acrylic backing. Letters shall ASI/2 pressure-sensitive vinyl letters. Signs shall have 1-inch border around perimeter.

1. One (1) each: Vacuum, Plant Water, Compressed Air, Sodium Hydroxide - NaOH, and Sodium Hypochlorite - NaOCl mounted above connections at the fill station (Colors as required in Section 15060).
2. Emergency Shower, Eye Bath: Mounted to each station (Green background, white letters 9" x 20").

2-1.04. Exterior Signs: No parking sign shall be 12" x 18" embossed steel with cast iron base and 1-inch diameter pipe standard, 36-inches high, with black enamel finish.

1. NO PARKING: To be located by the Owner. (White background, red letters).

PART 3- EXECUTION

3-1 INSTALLATION: General: Locate sign units and accessories where shown or directed, using mounting methods of the type described and in compliance with the manufacturer's instructions. Install signs level, plumb and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

3-2 CLEANING AND PROTECTION. At completion of the installation, clean soiled sign surfaces in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Engineer.

End of Section

SECTION 10990

MISCELLANEOUS BUILDING SPECIALTIES

PART I - GENERAL

1-1 SCOPE. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for all miscellaneous building specialties work. All work shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1-2. SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

Product data. Indicate material types, finishes and sizes, fabrication and installation details, and requirements.

Drawings indicating locations, installation details, and special requirements necessary for coordination. Provide cross sections and construction details of work bench.

1-3. QUALITY ASSURANCE. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM, American Society for Testing and Materials.
2. UL, Underwriters' Laboratories, Inc.

Manufacturers offering products that comply with these specifications include:

1. Elkhart Brass Manufacturing Company.
2. J.L. Industries, Inc.
3. Larsen Manufacturing Company.
4. Norris Industries.
5. Standard Fire Equipment Div./Zurn Industries, Inc.

1-4. DELIVERY, STORAGE, AND HANDLING. Deliver specialties in protective packaging. Store in packaging to prevent soiling and physical damage. Handle to prevent

damage to finished surfaces and operating mechanisms.

PART 2 - PRODUCTS

2-1. FIRE EXTINGUISHERS

Extinguishers: Multipurpose dry chemical extinguisher.

a. Capacity - 10 lbs.
b. UL Rating - 4A-60B:C.

Pressurized water extinguisher.

a. Capacity - 2-1/2 gallon.
b. UL rating - 2A, stainless steel finish.

Provide extinguishers complete with nozzle and pressure gauge.

Provide manufacturer's standard bracket supporting extinguisher at top and bottom, holding extinguisher off finished wall surface.

Fire Extinguisher Cabinets:

1. Type. Semi-recessed.
2. Size. Required for extinguishers.
3. Cabinet material and finish. Minimum 18 gauge steel, prefinished in white enamel.
4. Door and trim material. Minimum 18 gauge steel, prefinished in white enamel.
5. Door
    a. Type - Duo-panel with wire glass.
    b. Color - Red.
    c. Lettering - FIRE EXTINGUISHER in black; letters running vertically.
    6. Hardware - Equip door with full length piano hinge, roller catch, and pull.

PART 3 - EXECUTION

3-1. GENERAL. Install Fire Extinguisher cabinets in accordance with manufacturer's product data, plumb, level, and true to line and location.

3-2. INSTALLATION:

Fire Extinguisher Cabinets:

1. Secure in walls, plumb and level, attached to structure.

2. Set at 5'-6" from finish floor to top of cabinet.
3. Caulk perimeter with sealant in accord with Caulking and Sealants section.
4. Install extinguishers just prior to Date of Substantial Completion, properly charged.

Bracket Mounted Extinguishers:

1. Install 5'-6" above finish floor to extinguisher top.
2. Install extinguishers just prior to Date of Substantial Completion, properly charged.

Prefinished Surfaces and Glass: Protect from damage or staining. Clean surfaces and polish glass both sides just prior to Date of Substantial Completion in accordance with manufacturer's recommendations and repair any damage to adjacent surfaces.

Leave items ready to receive final finish specified in other sections.

End of Section

SECTION 10430

EXTERIOR SIGNS

PART 1 - GENERAL

1-1 SCOPE. Work described in this Section includes providing all non-illuminated wall mounted and post mounted signs complete with all components by single manufacturer at locations indicated on the Drawings. Provide all exterior signs from same manufacturer.

Related Work Specified Elsewhere:

1. Section 03300, Cast-In-Place Concrete.
2. Section 07900, Caulking and Sealants.

1-2 SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

Shop drawings: Submit complete shop drawings; indicate all materials, sizes, configurations, applicable substrate mountings, and required location of connections provided in other sections. Specifically indicate tolerances required from other sections for base mounted modules.

b. Submit typography sample for copy.
c. Submit art work for special graphics.
d. Templates - Furnish templates required for locations of anchors installed by others.

Product data.

a. Submit manufacturer's signed statement regarding compliance with Article 1.04, Paragraph A.
b. Submit manufacturer's product literature indicating units and designs selected.
c. Submit maintenance data and cleaning requirements for all exterior surfaces.

1-3. QUALITY ASSURANCE: Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. AA, Aluminum Association.
2. ANSI, American National Standards Institute.
3. ASTM, American Society for Testing and Materials.

Manufacturer Qualifications: Provide Work required under this section from manufacturers regularly engaged in Work of this magnitude and scope for minimum of five years.

Pre-installation Conference: Closely coordinate tolerances required in this section for installation to bases supplied in other sections.

1-4 QUALITY STANDARDS. Acceptable Product:

Other manufacturer's products are acceptable if submitted in accord with Product Options and Substitutions section and are in strict compliance with these specified requirements.

1-5. DELIVERY, STORAGE, AND HANDLING. Delivery of Materials: Coordinate delivery of Work to Project site under this section for immediate installation.

Handling materials and equipment: Handle signage in careful manner in order not to damage or mar surfaces of signs or adjacent finish surfaces as applicable.

1-6. SEQUENCING AND SCHEDULING. Coordinate installation with adjacent finish materials in manner not to destroy adjacent surfaces.

Coordinate with other sections for cast-in or built-in anchors and mounting hardware required in Work accomplished in other sections.

1-7. WARRANTY. Provide manufacturer's standard five year limited warranty covering coating degradation, chalking, fading, and fiberglass delaminating.

PART 2 - PRODUCTS

2-1. MANUFACTURED UNITS

Types:

1. Post and panel.
2. Post and panel pylon.
3. Wall mounted panel.

Design units with selected components specified in Article 2.02.

2-2. COMPONENTS

Graphics Panel Module:
Posts:

1. Material.
2. Post profile.
3. Finish and color.

Design post for panel size: individual lengths required by manufacturer for in ground mount.

Graphics: Special note. Use of clear overcoat on completed graphics regardless of colors or types selected is strictly prohibited.

Pressure sensitive graphics (PSG) colors. Selected by Engineer.

Type.

a. Size -
b. Style - Selected by Engineer.
c. Type code -

2-3. ACCESSORIES. Provide miscellaneous hardware and items required for installation of in-ground and base mounted sign modules.

2-4. FABRICATION. Fabricate units to configurations indicated on reviewed shop drawings. Internally reinforce units in accord with reviewed shop drawings.

Provide copy required on reviewed shop drawings in accord with manufacturer's standard procedures.

Fabricate posts to lengths required for in-ground mounting.

PART 3 - EXECUTION

3-1. EXAMINATION. Examine areas to receive sign modules; verify for proper location of cast-in anchors installed under other sections.

Notify Engineer in writing of unacceptable substrate or improper location of anchors. Beginning Work indicates acceptance of substrate. Subsequent modifications to substrate or modules becomes this section's complete responsibility.

3-2. INSTALLATION. Install sign modules in locations indicated on drawings in accord with reviewed shop drawings. Square, plumb, and level units.

Bore required holes for post mounted sign modules; set and align posts; fill and compact space around post with concrete.

3-3. CLEANING. Clean all exposed surfaces just prior to Date of Substantial

Completion in accord with manufacturer's written cleaning instructions.

3-4. SCHEDULES. Coordinate schedules with Engineer.

3-5. EXTERIOR SIGN TYPES

E.1: Parking Space Identity: Polysign Series 4160.2. Size: Panel-1/4" x 12" x 12". Post-2" x 2" x 4'. Posts and panel to have painted finish. Pressure-sensitive graphics and field color to be chosen from standards. "Visitor" to be 2" high; "Symbol" to be 8" high.

Format: center/center.

E.2: Directional Sign: Polysign Series 4120.1. size: 2" X 48" high x 24" wide. Posts and panel to have painted finish. Pressure-sensitive graphics and field color to be chosen from standards. Arrows to be 3"; lettering not to exceed 2" high. Units to have 6' posts furnished. Format: Flush left.

E.3: Building ID: Cast aluminum dimensional letters. Letters to have 6" cap height. Type style and Baked Enamel color to be chosen from manufacturer's standards. Letters to be stud mounted, projected from the wall surface 1/4". Format: center/center. Location to be determined by City and Engineer.

End of Section

SECTION 10430

EXTERIOR SIGNS

PART 1 - GENERAL

1-1 SCOPE. Work described in this Section includes providing all non-illuminated wall mounted and post mounted signs complete with all components by single manufacturer at locations indicated on the Drawings. Provide all exterior signs from same manufacturer.

Related Work Specified Elsewhere:

1. Section 03300, Cast-In-Place Concrete.
2. Section 07900, Caulking and Sealants.

1-2 SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

Shop drawings: Submit complete shop drawings; indicate all materials, sizes, configurations, applicable substrate mountings, and required location of connections provided in other sections. Specifically indicate tolerances required from other sections for base mounted modules.

b. Submit typography sample for copy.
c. Submit art work for special graphics.
d. Templates - Furnish templates required for locations of anchors installed by others.

Product data.

a. Submit manufacturer's signed statement regarding compliance with Article 1.04, Paragraph A.
b. Submit manufacturer's product literature indicating units and designs selected.
c. Submit maintenance data and cleaning requirements for all exterior surfaces.

1-3. QUALITY ASSURANCE: Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. AA, Aluminum Association.
2. ANSI, American National Standards Institute.
3. ASTM, American Society for Testing and Materials.

Manufacturer Qualifications: Provide Work required under this section from manufacturers regularly engaged in Work of this magnitude and scope for minimum of five years.

Pre-installation Conference: Closely coordinate tolerances required in this section for installation to bases supplied in other sections.

1-4 QUALITY STANDARDS. Acceptable Product:

Other manufacturer's products are acceptable if submitted in accord with Product Options and Substitutions section and are in strict compliance with these specified requirements.

1-5. DELIVERY, STORAGE, AND HANDLING. Delivery of Materials: Coordinate delivery of Work to Project site under this section for immediate installation.

Handling materials and equipment: Handle signage in careful manner in order not to damage or mar surfaces of signs or adjacent finish surfaces as applicable.

1-6. SEQUENCING AND SCHEDULING. Coordinate installation with adjacent finish materials in manner not to destroy adjacent surfaces.

Coordinate with other sections for cast-in or built-in anchors and mounting hardware required in Work accomplished in other sections.

1-7. WARRANTY. Provide manufacturer's standard five year limited warranty covering coating degradation, chalking, fading, and fiberglass delaminating.

PART 2 - PRODUCTS

2-1. MANUFACTURED UNITS

Types:

1. Post and panel.
2. Post and panel pylon.
3. Wall mounted panel.

Design units with selected components specified in Article 2.02.

2-2. COMPONENTS

Graphics Panel Module:
Posts:

1. Material.
2. Post profile.
3. Finish and color.

Design post for panel size: individual lengths required by manufacturer for in ground mount.

Graphics: Special note. Use of clear overcoat on completed graphics regardless of colors or types selected is strictly prohibited.

Pressure sensitive graphics (PSG) colors. Selected by Engineer.

Type.

a. Size -
b. Style - Selected by Engineer.
c. Type code -

2-3. ACCESSORIES. Provide miscellaneous hardware and items required for installation of in-ground and base mounted sign modules.

2-4. FABRICATION. Fabricate units to configurations indicated on reviewed shop drawings. Internally reinforce units in accord with reviewed shop drawings.

Provide copy required on reviewed shop drawings in accord with manufacturer's standard procedures.

Fabricate posts to lengths required for in-ground mounting.

PART 3 - EXECUTION

3-1. EXAMINATION. Examine areas to receive sign modules; verify for proper location of cast-in anchors installed under other sections.

Notify Engineer in writing of unacceptable substrate or improper location of anchors. Beginning Work indicates acceptance of substrate. Subsequent modifications to substrate or modules becomes this section's complete responsibility.

3-2. INSTALLATION. Install sign modules in locations indicated on drawings in accord with reviewed shop drawings. Square, plumb, and level units.

Bore required holes for post mounted sign modules; set and align posts; fill and compact space around post with concrete.

3-3. CLEANING. Clean all exposed surfaces just prior to Date of Substantial

Completion in accord with manufacturer's written cleaning instructions.

3-4. SCHEDULES. Coordinate schedules with Engineer.

3-5. EXTERIOR SIGN TYPES

E.1: Parking Space Identity: Polysign Series 4160.2. Size: Panel-1/4" x 12" x 12". Post-2" x 2" x 4'. Posts and panel to have painted finish. Pressure-sensitive graphics and field color to be chosen from standards. "Visitor" to be 2" high; "Symbol" to be 8" high.

Format: center/center.

E.2: Directional Sign: Polysign Series 4120.1. size: 2" X 48" high x 24" wide. Posts and panel to have painted finish. Pressure-sensitive graphics and field color to be chosen from standards. Arrows to be 3"; lettering not to exceed 2" high. Units to have 6' posts furnished. Format: Flush left.

E.3: Building ID: Cast aluminum dimensional letters. Letters to have 6" cap height. Type style and Baked Enamel color to be chosen from manufacturer's standards. Letters to be stud mounted, projected from the wall surface 1/4". Format: center/center. Location to be determined by City and Engineer.

End of Section

SECTION 10440

IDENTIFYING DEVICES

PART 1 - GENERAL

1-1 DESCRIPTION. The Contractor shall furnish all the materials for and shall properly erect and install all identifying devices at the locations shown and as indicated on the Drawings, and as specified herein.

This shall include all identification signs and warning signs, including supports, fastening devices, and accessories, and all labor, materials, tools, and appurtenances required to complete the Work.

It is the intent of this Specification that the installation shall be complete in all respects and ready for use. The Contractor shall be responsible for all incidental details and for any special construction necessary to complete the work in an acceptable manner.

Related Work Specified Elsewhere:

1. Section 10990, Miscellaneous Building Specialties.
2. Section 15440, Emergency Shower and Eyewash Fixtures.
3. Section 15060, Piping and Appurtenances.

1-2 SUBMITTALS: Product Data: Submit manufacturer's technical data and installation instructions for each type of sign required.

Samples: Submit samples of each sign form and materials showing finished, colors, surface textures and qualities of manufacturer and design of each sign component including graphics.

1-3 QUALITY ASSURANCE: Uniformity of manufacturer: For each sign form and graphic image process indicated furnish products of single manufacturer.

Quality of signage shall be not less than ASI-SPE construction.

PART 2 - PRODUCTS

2-1 MATERIALS.

2-1.01. General: Identifying devices shall be of the type and materials specified for each category. Unless otherwise indicated, signs shall be the manufacturer's stock items.

2-1.02. Life Safety Signs: Signs shall be butyrate with red lettering on white background, and conforming to OSHA regulations. Sign denoting fire extinguisher location shall be vinyl with pressure-sensitive adhesive backing.

1. NO SMOKING: Located at all entrance doors.
2. FIRE EXTINGUISHER: Located above all extinguishers.
3. DANGER - DO NOT DRINK THIS WATER: Located at each water station.
4. DANGER - CONFINED SPACE ENTRY- ENTER BY PERMIT ONLY: Mounted on west wall above the stairs to air discharge channel. (White background, red and black letters, 14" x 20").

2-1.03. Interior and Directional Signs: Signs shall be ASI/2 type A, constructed of 0.015-inch vinyl laminated to 1/4-inch acrylic backing. Letters shall ASI/2 pressure-sensitive vinyl letters. Signs shall have 1-inch border around perimeter.

1. One (1) each: Vacuum, Plant Water, Compressed Air, Sodium Hydroxide - NaOH, and Sodium Hypochlorite - NaOCl mounted above connections at the fill station (Colors as required in Section 15060).
2. Emergency Shower, Eye Bath: Mounted to each station (Green background, white letters 9" x 20").

2-1.04. Exterior Signs: No parking sign shall be 12" x 18" embossed steel with cast iron base and 1-inch diameter pipe standard, 36-inches high, with black enamel finish.

1. NO PARKING: To be located by the Owner. (White background, red letters).

PART 3- EXECUTION

3-1 INSTALLATION: General: Locate sign units and accessories where shown or directed, using mounting methods of the type described and in compliance with the manufacturer's instructions. Install signs level, plumb and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

3-2 CLEANING AND PROTECTION. At completion of the installation, clean soiled sign surfaces in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Engineer.

End of Section

SECTION 10990

MISCELLANEOUS BUILDING SPECIALTIES

PART I - GENERAL

1-1 SCOPE. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for all miscellaneous building specialties work. All work shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1-2. SUBMITTALS. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

Product data. Indicate material types, finishes and sizes, fabrication and installation details, and requirements.

Drawings indicating locations, installation details, and special requirements necessary for coordination. Provide cross sections and construction details of work bench.

1-3. QUALITY ASSURANCE. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM, American Society for Testing and Materials.
2. UL, Underwriters' Laboratories, Inc.

Manufacturers offering products that comply with these specifications include:

1. Elkhart Brass Manufacturing Company.
2. J.L. Industries, Inc.
3. Larsen Manufacturing Company.
4. Norris Industries.
5. Standard Fire Equipment Div./Zurn Industries, Inc.

1-4. DELIVERY, STORAGE, AND HANDLING. Deliver specialties in protective packaging. Store in packaging to prevent soiling and physical damage. Handle to prevent

damage to finished surfaces and operating mechanisms.

PART 2 - PRODUCTS

2-1. FIRE EXTINGUISHERS

Extinguishers: Multipurpose dry chemical extinguisher.

a. Capacity - 10 lbs.
b. UL Rating - 4A-60B:C.

Pressurized water extinguisher.

a. Capacity - 2-1/2 gallon.
b. UL rating - 2A, stainless steel finish.

Provide extinguishers complete with nozzle and pressure gauge.

Provide manufacturer's standard bracket supporting extinguisher at top and bottom, holding extinguisher off finished wall surface.

Fire Extinguisher Cabinets:

1. Type. Semi-recessed.
2. Size. Required for extinguishers.
3. Cabinet material and finish. Minimum 18 gauge steel, prefinished in white enamel.
4. Door and trim material. Minimum 18 gauge steel, prefinished in white enamel.
5. Door
    a. Type - Duo-panel with wire glass.
    b. Color - Red.
    c. Lettering - FIRE EXTINGUISHER in black; letters running vertically.
    6. Hardware - Equip door with full length piano hinge, roller catch, and pull.

PART 3 - EXECUTION

3-1. GENERAL. Install Fire Extinguisher cabinets in accordance with manufacturer's product data, plumb, level, and true to line and location.

3-2. INSTALLATION:

Fire Extinguisher Cabinets:

1. Secure in walls, plumb and level, attached to structure.

2. Set at 5'-6" from finish floor to top of cabinet.
3. Caulk perimeter with sealant in accord with Caulking and Sealants section.
4. Install extinguishers just prior to Date of Substantial Completion, properly charged.

Bracket Mounted Extinguishers:

1. Install 5'-6" above finish floor to extinguisher top.
2. Install extinguishers just prior to Date of Substantial Completion, properly charged.

Prefinished Surfaces and Glass: Protect from damage or staining. Clean surfaces and polish glass both sides just prior to Date of Substantial Completion in accordance with manufacturer's recommendations and repair any damage to adjacent surfaces.

Leave items ready to receive final finish specified in other sections.

End of Section

SECTION 11000

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 – GENERAL

1-1. SCOPE: General: This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of the individual equipment specification section.

Equipment Lists: Equipment lists, presented in these specifications and as specified on the Drawings, are included for the convenience of the City's Engineer and Contractor and are not complete listings of all equipment, devices and material to be provided under this contract. The Contractor agrees to prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1-2. QUALITY ASSURANCE. Arrangement: The arrangement of equipment shown on the Drawings is based upon information available to the City at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual equipment installation requirements. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations.

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

Reference	Title
ABMA Std 9-90	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11-90	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1 89	Unified Screw Threads
ANSI B1.20.1 83	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125 and 250)
ANSI B16.1 89	Cast Iron Pipe Flanges and Flanged Fittings, Class 125
ANSI B18.2.1 81	Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Log Screws

Reference	Title
ANSI B18.2.2 87 ANSI S2.19	Square and Hex Nuts Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

Unit Responsibility: The unit responsbility for equipment systems made up of two or more components shall be provided in accordance with Section 01600.

The Contractor shall assure that all equipment systems provided for the project are products for which unit responsibility has been accepted by the responsible manufacturer. Where the detailed specification requires the Contractor to furnish a certificate from the Unit Responsibility Manufacturer, such certificates shall conform to the content, form and style of Form 11000-C specified in Section 01600, shall be signed by an officer of the manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.

Balance: Unless specified otherwise, all rotating elements in motors, pumps, centrifuge and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$e = \frac{W}{16N}$$

1. Where:
   - e = imbalance, ounce-inches, maximum
   - W = Weight of the balanced assembly, pounds mass
   - N = Maximum operational speed, rpm

Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data.

PART 2 – PRODUCTS

2-1. FLANGES AND PIPE THREADS. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2-2. BEARINGS. Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum B 10 rating life of 100,000 hours.

The rating life shall be determined using the maximum equipment operating speed.

Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

All bearings accessible to touch and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature or appropriate shielding shall be provided that will prevent inadvertent human contact.

2-3. V BELT ASSEMBLIES. Unless otherwise specified, V belt assemblies shall be Dodge Dyna V belts with matching Dyna V sheaves and Dodge Taper lock bushings, Wood's Ultra V belts with matching Ultra V sheaves and Wood's Sure Grip bushings, or equal.

Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion-proof equipment is specified.

2-4. PUMP SHAFT SEALS. General: Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

Mechanical Seals: Where mechanical seals are specified, the seal shall be of a nondestructive (nonfretting) type which requires no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area. Mechanical seals shall be the cartridge type, requiring no field assembly, other than insertion into the pump. Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C. Rotary faces shall be tungsten carbide or silicon carbide. Stationary faces shall be ceramic, tungsten carbide, or silicon carbide.

Unless otherwise specified, mechanical seals for overhung shaft, constant speed pumps and split case, centrifugal pumps shall be self-aligning, single, rotary type, Chesterton 155, Crane 88 S, or equal.

Unless otherwise specified, mechanical seals for variable speed, overhung shaft pumps shall be double, balanced, self-aligning type, Crane 88 D, Chesterton 222 or 255, or equal.

Boxes for mechanical seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.) shall be drilled and tapped for installation of clean water barrier fluid supply piping.

Seals for all vertical pumps (whether column or volute type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start-up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed specifications, permissive confirmation automatic vent systems shall be provided.

Shaft Packing: Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in paragraph 11000-2-4.B for the applicable pump and operating conditions.

Unless otherwise specified, lantern rings shall be bronze or teflon, packing shall be die molded packing rings of nonasbestos material suitable for the intended service and as

recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC-20.

Threaded lantern ring removal tools shall be provided with spare parts for each pump. The impeller end of the packing on all but line shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

The section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve.

Minimum shaft sleeve thickness shall be 3/8 inch.

2-5. COUPLINGS. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taperlock bushings which shall give the equivalent of a shrunk on fit. There shall be no metal to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2-6. GUARDS: Exposed moving parts shall be provided with guards which meet the requirements of OSHA. Guards shall be fabricated of 14 gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2-7. CAUTION SIGNS. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION –

AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the Drawings. Signs shall be installed near guarded moving parts.

2-8. GAGE TAPS, TEST PLUGS AND GAGES. Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Divisions 13 and 15, respectively.

2-9. NAMEPLATES. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible location with stainless steel screws or drive pins.

2.10. LUBRICANTS. The Contractor shall provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the City's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the City with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2-11. ANCHOR BOLTS. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05501. Unless otherwise stated in the detailed specification, anchor bolt materials shall conform to the provisions of Section 05501.

2-12. SPARE PARTS. Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

PART 3 – EXECUTION

3-1. INSTALLATION. Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

End of Section

SECTION 11002

RIGID EQUIPMENT MOUNTS

PART 1 – GENERAL

1-1. DESCRIPTION.

1-1.01. SCOPE. This section specifies minimum requirements for rigid equipment mounts (baseplates, soleplates, and mounting blocks) and their installation on equipment pads. Completed equipment supports shall consist of equipment pads, equipment anchors, and rigid equipment mounts (baseplates, soleplates, or mounting blocks) set in grout.

1-1.02. REQUIREMENTS. Unless alternate requirements for equipment mounts are specified in the applicable equipment specification, the requirements of this section shall be applied to rigid mounts for all rotating or reciprocating equipment that is used to mix, convey, or pressurize fluids (gases and liquids). The requirements of this section shall also apply whenever referenced in specifications for other types of equipment. If conflict exists between this section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail. Non-rigid equipment mounts (vibration isolation systems) are specified in Section 11021. Mounting and alignment of equipment installed on equipment mounts (baseplates, soleplates, and mounting blocks) is specified in Section 11005.

1-2 DEFINITIONS: Specific equipment mounting terminology used in this section conforms to the following definitions:

1-2.01. Baseplate: Fabricated (welded structural steel elements), cast, or plate steel base providing a common mounting element on which the legs, feet, or mounting surfaces of equipment are mounted by means of bolted connections.

1-2.02. Soleplate: A machined plate, spanning an opening in the floor or equipment pad, providing a common mounting element on which the legs, feet, or mounting surfaces of equipment are mounted by means of bolted connections.

1-2.03. Mounting Blocks: Multiple smaller baseplates on which individual legs, feet or equipment supports are mounted when equipment or drivers are not fastened to a common baseplate or sole plate.

1-2.04. Equipment Pad: Concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.

1-2.05. Mounting Pads: Thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers are bolted and/or doweled to the baseplate or soleplate.

1-2.06. Leveling Blocks: Temporary steel blocks placed under baseplates, soleplates, or a mounting block at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or mounting blocks prior to grouting.

1-2.07. Shims: Thin stainless steel plates of a uniform thickness installed on top of Leveling Blocks for fine adjustment of level. Shims may also be used between equipment or drivers and baseplates, soleplates, or mounting blocks for equipment alignment purposes specified in Section 11005.

1-2.08. Wedges: Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges are used between equipment pads and baseplates, soleplates, or mounting blocks for the purpose of leveling baseplates, soleplates, or mounting blocks.

1-2.09. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or mounting blocks for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or mounting blocks.

1-2.10. Reinforcement Dowels: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.

1-2.11. Machine Alignment Dowels: Tapered diameter rods inserted in tapered diameter holes for the purpose of aligning machinery. The practice of drilling tapered diameter holes through machinery and baseplates so that Machine Alignment Dowels may be inserted to facilitate alignment of machinery is known as Doweling.

1-2.12. Leveling Position: A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and mounting blocks prior to grouting.

1-2.13. Grout Manufacturer: Refers to the manufacturer of the epoxy grout system used for installation of rigid equipment mounts.

1-2.14. Grout Manufacturer's Technical Representative(s): Refers to the technical representative(s) of the Grout Manufacturer.

1-3. EQUIPMENT MOUNTING REQUIREMENTS: Unless otherwise specified, equipment and drivers shall be rigidly mounted on a common cast iron or fabricated steel baseplate or soleplate grouted into place on a concrete equipment pad. Under no circumstances shall baseplates, soleplates, or mounting blocks be grouted directly to concrete slabs or floors. Equipment that uses an interdependent equipment and driver

mounting configuration (equipment that is bolted onto the driver frame and equipment that supports the driver entirely from the equipment frame) may be bolted directly on concrete or grout surfaces of equipment pads if the driver is less than five horsepower. Bolting equipment directly on concrete or grout surfaces of equipment pads is not acceptable for equipment and drivers that do not have an interdependent equipment and driver mounting configuration.

1-4. QUALITY ASSURANCE

1-4.01. REFERENCES: This section contains references to the following documents. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.

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

Reference	Title
ANSI/HI 1.4	Centrifugal Pumps – Installation, Operation and Maintenance
ANSI/HI 2.4	Vertical Pumps – Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2
IBC	2001 International Building Code (including local amendments)

1-5. QUALITY CONTROL BY CONTRACTOR:

1-5.01. REQUIREMENTS. To demonstrate conformance with the specified requirements for rigid equipment mounts, the Contractor shall provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. The testing laboratory shall sample and test equipment mount related materials as indicated in this Section (11002). Costs of testing laboratory services shall be borne by the Contractor.

For equipment with drivers 20 horsepower and greater, the Contractor shall furnish the services of a grout manufacturer's technical representative that has been factory trained by the grout manufacturer. The grout manufacturer's technical representative shall perform training and quality control of epoxy grout installation for rigid equipment mounts as indicated in this section (11002).

1-6. SUBMITTALS. The following information shall be provided in accordance with the submittal requirements specified in the General Conditions.

1-6.01. SPECIFICATION. A copy of this specification section, with addendum updates included, (referenced sections need not be included for Section 11002) with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration. Copies of this specification section shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

1-6.02. SCHEDULE. Schedule of rigid equipment mount installations specified in paragraph 11002-2.01.

1-6.03. REQUIRMENTS. Name, employer and certificates or other information documenting compliance with the journeyman qualifications requirements for millwrights who will install rigid equipment mounts, as specified in paragraph 11002-3.03. C.

1-6.04. CERTIFICATES. Certificates or other documentation issued by the epoxy grout manufacturer that demonstrates that the grout manufacturer's technical representative

has been factory trained on installation of epoxy grout for equipment mounts, as specified in paragraph 11002-1.02 B. 2.

1-6.05. SHOP DRAWINGS. Shop drawings for all equipment pads, equipment anchors, and baseplate, soleplate or mounting block details. Shop drawings shall depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate; soleplate; or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or mounting blocks shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

PART 2 - PRODUCTS

2-1. GENERAL. Prior to initiating any installation efforts, the Contractor shall produce a rigid equipment mount installation schedule containing the expected dates for installing equipment anchors and preparation of equipment pads for leveling, grouting, and final equipment anchor clamping for each item of equipment. The schedule shall list the equipment, by equipment tag number, and shall list applicable equipment specification section, motor horsepower, and name of the Contractor's representative responsible for quality control during installation of rigid equipment mounts. The schedule shall be accompanied by written verification of equipment anchor clamping torque from the manufacturer of each item of equipment to be installed with rigid equipment mounts.

2-2. CONCRETE EQUIPMENT PADS. Concrete equipment pads shall be as shown in the structural details for equipment pads and equipment anchors for rigid mounted equipment.

2-2.01. ANCHOR. The Contractor shall submit equipment anchor calculations for all equipment with drivers 20 horsepower and greater. Equipment anchor calculations shall demonstrate that equipment anchor size, embedment, and edge distance comply with the UBC and local governing code and are sufficient to resist the maximum lateral and vertical forces specified in paragraph 11000-2.11. Equipment anchor calculations shall be sealed by a registered structural or civil engineer licensed in the State of Georgia.

2-3 BASEPLATES, SOLEPLATES, AND MOUNTING BLOCKS

2-3.01 General: Unless otherwise specified, Type I baseplates, soleplates, and mounting blocks shall be a minimum of 1 inch thick for equipment with drivers 20 horsepower and larger.

Type I baseplates, soleplates, and mounting blocks shall have edges of surfaces bearing on grout rounded to a radius of not less than 0.25 inch. Horizontal corners of Type I baseplates, soleplates, or mounting blocks shall be rounded to a radius of not less than two inches to avoid producing stress risers on the grouted foundation. Grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2 ½ inches in diameter for cementitious nonshrink grout) shall be provided in all baseplates and soleplates and all baseplates and soleplates shall have grout release holes. Mounting blocks may be grouted without grout pouring holes provided that no dimension of the mounting block (width or length) exceeds 18 inches. Grout relief or vent holes (minimum 1 inch in diameter) shall be provided in all baseplates, soleplates, and mounting blocks. Internal stiffeners shall be provided on all cast and fabricated baseplates and shall be designed to allow free flow of grout from one section of the baseplate to another. The minimum acceptable opening in cross bracing and stiffeners shall be 2 inches high by 6 inches in width. All welds shall be continuous and free from skips, blowholes, laps and pockets.

Mounting holes for equipment anchors shall be drilled through baseplates, soleplates, and mounting blocks. Mounting holes for equipment anchors shall not be burned out and they shall not be open slots. All mounting studs shall be Type 316 stainless steel. An anti-seize or anti-galling compound, as specified in paragraph 11002-2.06, shall be applied to all mounting stud threads prior to installing nuts on mounting studs.

Terminations requiring connections to baseplates, soleplates, or mounting blocks shall be acorn nuts welded to the under side of the baseplate or nuts welded to the underside of the baseplate and plugged with cork, plastic plugs or grease. In no case shall the fastener terminate only into the metal base. Where baseplates, soleplates, or mounting blocks are leveled using jackscrews, jackscrew threads shall be tapped in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.

Mounting pads for equipment shall be machined after all welding and stress relieving and shall be coplanar within 0.002 inch per foot in all directions. Mounting pads shall extend not less than 0.5 inch beyond the perimeter of the foot or mounting surface of the mounted equipment, in any direction.

Equipment baseplates shall provide common support for the equipment and driver (and flywheel, if one is specified). Baseplates for equipment with drivers 20 horsepower and greater shall be furnished with eight transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates. Two of the eight transverse alignment/positioning jackscrews shall be installed in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Eight additional jackscrews shall be provided for transverse alignment of the flywheel, if flywheels are specified.)

2-3.02 Type I Baseplates: Type I baseplates shall be plate or fabricated structural steel baseplates with thickened steel mounting pads for doweling and bolting equipment to the baseplate. The baseplates shall be rectangular in shape for equipment other than centrifugal refrigeration machines and pump baseplates, which may be "T" or "L" shaped to accommodate the equipment drive and accessories. Baseplates for split case pumps shall include supports for suction and discharge elbows, if required by the specified configuration. Perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the baseplate. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.

2-3.03 Type II/III Baseplates: Type II and Type III baseplates, which are applicable for vibration isolation mounting, are specified in Section 11021.

2-3.04 Type IV Baseplates: Type IV baseplates shall be cast iron with thickened mounting pads for doweling and bolting equipment to the baseplate. Cast iron baseplates shall be sealed in accordance with the requirements for bleeding surfaces specified in Section 09900 prior to grouting.

2-3.05 Soleplates: Where soleplates are provided, the underside shall be scribed with the words “THIS SIDE DOWN” using welding rod material prior to milling the mounting pad for each equipment foot or mounting surface. Mounting surfaces and mounting pads on soleplates shall be milled flat to a tolerance of not less than 0.002 inch per foot in all directions. Soleplates shall be machined for an indexed fit to the mounted equipment or driver.

2-3.06 Mounting Blocks: Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of a common baseplate or soleplate and equipment pad. In such instances, the equipment shall be supported at the feet or mounting surfaces on individual mounting blocks, which shall be leveled and grouted into place on the individual piers or equipment pads as specified in this section. Vertical volute-type pumps weighing more than 2,000 pounds shall be mounted on mounting blocks under each foot or mounting surface for the pump. All mounting blocks shall be furnished with jackscrew threads (three locations, minimum) tapped in the mounting block for the purpose of leveling mounting blocks with jackscrews.

2-4 GROUT FOR EQUIPMENT PADS

2-4.01 EPOXY GROUT FOR EQUIPMENT MOUNTING: Unless otherwise specified, grout for setting bearing surfaces of baseplates, soleplates, and mounting blocks on equipment pads shall be Epoxy Grout for Equipment Mounting as specified in Section 03600. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it shall mean Epoxy Grout for Equipment Mounting.

2-4.02 CEMENTITIOUS NONSHRINK GROUT: Cementitious Nonshrink Grout, specified in Section 03600, may be used for setting bearing surfaces of baseplates, soleplates, or mounting blocks on equipment pads where equipment drivers are 20 horsepower and smaller and the combined weight of equipment and driver is less than 1000 pounds. Where the term nonshrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it shall mean Cementitious Nonshrink Grout. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

2-5 EPOXY PRIMER. Epoxy primer shall be a lead-free, chrome-free, rust-inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer shall be a product of the epoxy grout manufacturer.

2-6 ANTI-SEIZE/ANTI-GALLING COMPOUND. Anti-seize or anti-galling compound shall be a molybdenum disulfide and graphite combination in an aluminum complex base grease conforming to MIL-PRF-907E. Acceptable products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or equal.

2-7 PRODUCT DATA. The following information shall be provided in accordance with the product data requirements specified in the General Conditions:

1. Equipment anchor calculations specified in paragraph 11002-2.02.
2. Results of grout strength tests, as specified in paragraph 11002-3.03 D.
3. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (11002-A), as specified in paragraph 11002-3.02 B.
4. List of Contractor's equipment installation staff that has completed epoxy grout manufacturer's grout installation training specified in paragraph 11002-3.02 A.

PART 3 – EXECUTION

3-1. GENERAL.

3-1.01. GROUTING. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems. Unless the Engineer accepts an alternate installation procedure in writing, baseplates, soleplates, and mounting blocks shall be leveled and grouted with the equipment removed. Pumps shall be installed in accordance with this section and ANSI/HI 1.4 or ANSI/HI 2.4, as appropriate for the type of pumping equipment installed.

3-1.02. CONNECTIONS. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections.

Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, the Contractor shall delete any flexible coupling (including equipment connection fittings) shown on the drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:

1. The equipment pad shall be prepared as shown on the details for rigid equipment mounts
2. The baseplate, soleplate, or mounting blocks supporting the equipment shall be installed, leveled, and grouted in place as specified in this section.
3. The equipment shall be installed, aligned and doweled in place as specified in Section 11005.
4. The piping shall be installed and aligned to the equipment connections and the field piping connections without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints shall be bolted up and pressure tested.
5. All piping shall be fully supported by supports designed to accept their full weight and thrust forces.
6. The final sections of piping shall be aligned with the equipment and field connections without the use of jacks, chain falls or other devices to force it into alignment.
7. The final piping joints shall be welded only after the previous steps have been completed and accepted by the Engineer.

3-2 EPOXY GROUT TRAINING AND QUALITY CONTROL

3-2.01 EPOXY GROUT TRAINING: Prior to commencing rigid equipment mount installation work on equipment pads, the Contractor shall furnish the services of a grout manufacturer's technical representative to conduct a training school for the workers that will be using the epoxy grout for rigid equipment mount installations.. The school shall be not less than 4 hours in length and shall cover all aspects of using the products, from mixing to application. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. The epoxy grout manufacturer shall furnish a list of school attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

3-2.02. EPOXY GROUT QUALITY CONTROL. For equipment with drivers 20 horsepower and greater, the epoxy grout manufacturer's technical representative shall provide quality control services for epoxy grout installation in rigid equipment mounts. The epoxy grout manufacturer's technical representative shall be on site to inspect and verify that the application personnel have successfully performed surface preparation, epoxy grout application, and Quality Control Inspection in accordance with these specifications for a representative portion of the epoxy grout installation work.

Specifically, the epoxy grout manufacturer's technical representative shall perform the following services for at least one rigid equipment mount installation for each equipment type and size:

a. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
b. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.
c. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
d. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
e. Inspect preparation and application of epoxy grout form work for conformance to the specifications.
f. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
g. Inspect epoxy grout for cure.
h. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
i. Conduct a final review of completed epoxy grout installation for conformance to these specifications.
j. Attest to conformance of the Contractor's work by signing appropriate entries in the "Rigid Equipment Mount Inspection Checklist," form 11002-A in Section 01600.

3-3 INSTALLATION

3-3.01 CONCRETE EQUIPMENT PAD PREPARATION. After the concrete is fully cured, the top of the equipment pad shall be roughened by chipping the surface. Chipping shall remove all laitance and defective or weak concrete and result in a rough surface profile with a 0.25 inch minimum amplitude. Chipping shall expose broken aggregate without dislodging unbroken aggregate from the cement matrix and shall not cause fractures below the concrete surface. Leveling surfaces of the concrete that have been finished smooth and level for baseplate, soleplate, or mounting block leveling at equipment anchors shall be protected from damage during chipping. A light duty, hand held pneumatic chipper with a chisel type tool shall be used for chipping the equipment pad concrete surface. Abrasive blast, bush-hammer, jackhammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted is not acceptable.

Prior to leveling activities, satisfactory removal of defective or weak concrete shall be demonstrated in the presence of the Engineer by operating the chipper on the chipped concrete surface at locations identified by the Engineer. The chipped surface of the concrete shall be such that the final baseplate, soleplate, or mounting block elevation results in the grout manufacturer's recommended grout thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate or underside of mounting block.

All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the surface protected with plastic sheeting until grout is installed.

Concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions shall be protected from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Leveling positions shall be restored by installing leveling blocks or leveling plates for jackscrews on a high compressive strength epoxy putty (Philadelphia Resins, Phillybond Blue 6A, or equal). Leveling blocks and leveling plates shall be installed level on the epoxy putty.

3-3.02. BASEPLATES, SOLEPLATES AND MOUNTING BLOCKS. All surfaces of baseplates, soleplates, and mounting blocks to be in contact with epoxy grout shall be cleaned to SSPC SP-6 and shall be primed with epoxy primer within 8 hours of cleaning.

3-3.03 LEVELING: All machinery shall be mounted and leveled by journeyman millwrights. Precision surveying equipment shall be used for leveling. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or mounting block with a plan dimension greater than 4 feet. Baseplates and mounting blocks shall be leveled to a maximum tolerance of 0.002 inch per foot or as otherwise required by the equipment manufacturer, if more stringent. Soleplates shall be leveled to 0.0005 inch per foot or as otherwise required by the equipment manufacturer, if more stringent. An anti-seize or anti-galling compound specified in paragraph 11002-2.06 shall be applied to all equipment anchor threads prior to beginning baseplate, soleplate, or mounting block leveling.

All baseplates, soleplates, and mounting blocks shall be leveled against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited. Unless otherwise specified, baseplates, mounting blocks, and soleplates shall be leveled as indicated in the leveling details. Leveling equipment and tools shall be stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates. Leveling nuts may be used for leveling baseplates and soleplates weighing less than 200 pounds. The use of leveling nuts for leveling mounting blocks is not permitted.

After baseplates, soleplates, or mounting blocks have been leveled on the leveling equipment, the Contractor shall clamp the baseplates, soleplates, or mounting blocks in position by installing the equipment anchor nuts and washers. Clamping torque shall be less than the final clamping torque specified in paragraph 11002-2.01, but sufficient to hold the baseplate, soleplate, or mounting block in position. The Contractor shall verify that the correct level and position of the baseplate, soleplate, or mounting block has been maintained after clamping on the leveling equipment.

Leveling blocks shall be stainless steel, four inches square and 1-1/2 inches thick with an open-ended slot terminating in the center for the equipment anchor. Leveling blocks

shall be machined flat on all horizontal surfaces and placed under the baseplate or soleplate at each equipment anchor. Shims shall be pre-cut stainless steel, slotted for removal after grouting, and shall extend not less than three inches beyond the baseplate, soleplate or mounting block. Leveling blocks and shims shall be coated with a light oil just prior to beginning the leveling and grouting work. Shims shall be placed so the tabs on the shims are easily accessible.

3-3.04 GROUTING: Grout forms shall be built of minimum 0.75 inch thick waterproof plywood and shall be securely braced (minimum brace size shall be two-by-four lumber). Forms shall be designed for a minimum of 6 inches hydrostatic head above the final elevation of the grout, to assist in flow during installation. Equipment mounting grout shall be furnished with expansion joints installed at four to six foot intervals, perpendicular to the centerline of baseplates.

Forms shall be coated with three coats of paste wax on all areas that will come in contact with the grout to prevent the grout from bonding to the forms. Forms shall be waxed before assembly to prevent accidental application of wax to surfaces where the grout is to bond. Before any forms are installed, all concrete surfaces that will contact epoxy grout shall be free from any foreign material, such as oil, sand, water, wax, grease, etc. Forms shall be liquid tight. Any open spaces or cracks in forms, or at the joint between forms and the foundation, shall be sealed off, using sealant, putty, or caulking compound. All outside vertical and horizontal edges of the grout shall have 45-degree chamfers as indicated in the equipment anchor details for rigid equipment mounts. Match chamfers in concrete portions of the equipment pad. Block outs shall be provided at all shimming and leveling positions to allow removal of leveling equipment and tools after the grout has cured. Jackscrews shall be coated with a light oil or other acceptable bond-breaking compound prior to grouting.

The 45-degree perimeter chamfer strip shall be located at the final elevation of the grout. The final elevation of the grout on baseplates with exposed I-beam or C-channel supports shall be at the top of the lower support flange. The top of the grout, on all other baseplates soleplates, and mounting blocks, shall be at least 1.0 inch above the bottom or underside of the baseplate, soleplate, or mounting block and shall not be higher than the top of the baseplate, soleplate, or mounting block. The grout's final elevation shall not be so high as to bond the equipment anchor nut and washer.

The resin and hardener for epoxy grout for equipment mounting shall be mixed in accordance with the epoxy grout manufacturer's recommendations. Epoxy grout shall be placed at the center of one end of the baseplate or soleplate and worked toward the ends in such a manner as to force the air out from beneath the baseplate or soleplate and out the vent holes, to eliminate voids. Epoxy grout shall be placed in a manner that avoids air entrapment, using a head box to pour grout into the grout holes. When the head box is moved to the next grout hole, a 6 inch high standpipe shall be placed over the grout hole and filled with grout. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.

The Contractor shall exercise care to never allow the grout to fall below the baseplate level once the grout has made contact with the baseplate. Grout placement shall be continuous until all portions of the space beneath the baseplate, soleplate, or mounting block have been filled. Subsequent batches of grout shall be prepared so as to be ready when the preceding batch has been placed. Under no circumstances shall the grouting operation be halted because of lack of grout mix. After the entire baseplate is full, 6 inch high standpipes shall be maintained over each grout hole, to continue purging of air. When the grout has started to take an initial set (typically this is determined by a noticeable increase in temperature and no flow of grout at the vent holes) the standpipes shall be removed and excess grout cleaned from all surfaces.

Where the cavity under a baseplate or mounting block extends above the elevation of the top of the bolting flange for the baseplate or mounting block, grouting may be completed in two pours. Under these circumstances, the first grout pour shall be continuous until the lower face of the bolting flange for the baseplate or mounting block is submerged in grout a minimum of one inch. The second grout pour shall be completed with standpipes and air purges as specified in the previous paragraph.

Grout forms shall be checked for leaks throughout grout pours. Leaks shall be repaired immediately to prevent formation of voids. A final check of baseplate, soleplate, or mounting block level and elevation shall be performed before the grout sets.
A grout sample shall be taken for each equipment pad that has a baseplate, soleplate, or mounting block set in grout. The sample shall be placed in a cylinder of sufficient size to yield three two-inch cubes as test samples. The samples shall be tagged with project name, date, time, the equipment number and ambient temperature at the time of placement. Once the epoxy grout cylinder has been completely filled, it shall be placed next to the foundation of the equipment being grouted and allowed to cure for 48 hours. After 48 hours, the test cylinder shall be tested in accordance with the grout manufacturer's recommendations by the independent testing laboratory specified in paragraph 11002-1.02 B. The results shall be reported directly to the Engineer. Forms shall be removed only after the grout has cured sufficiently and upon specific permission from the Engineer.

3-3.01 COMPLETION: Upon acceptance by the Engineer and the equipment manufacturer's representative and after the grout has reached sufficient strength, grout forms and block outs at leveling positions shall be removed. Leveling blocks and shims or wedges and support plates shall be removed, leveling nuts and jack screws shall be backed off to allow the grout to fully support the baseplate, mounting block, or soleplate. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.

The equipment anchor nuts shall be tightened, using calibrated indicating torque wrenches, to develop the full clamping force required by the equipment manufacturer.

Equipment anchor nuts shall be tightened in increments of not more than 25 percent of the final torque value in an alternating pattern to avoid stress concentration on the grout surface. After tightening equipment anchor nuts to final values, apply additional wax, grease, or mastic to all exposed portions of the equipment anchor beneath the baseplate, soleplate, or mounting block.

After applying additional wax or mastic to exposed portions of equipment anchors, block outs (pockets) for access to leveling nuts, leveling blocks and shims, or wedges shall be filled with the grout material installed under baseplates, soleplates, or mounting blocks and pointed after the equipment anchor nuts have been tightened to final values. Jackscrews shall be removed and holes in the baseplate, soleplate, or mounting blocks filled with a flexible sealant (silicone rubber) or a short cap screw.

Check for baseplate, soleplate, or mounting block movement (soft foot) by individually loosening and re-tightening each equipment anchor. Vertical movement at each equipment anchor shall be measured and recorded during loosening and retightening and shall not exceed 20 micrometers (0.001 inch). Vertical movement shall be measured using a magnetic-based dial indicator on the baseplate, soleplate, or mounting block referenced to the epoxy grout surface of the equipment pad or other approved method. Soft foot conditions shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or mounting blocks.

Check for grout voids by tapping along the upper surfaces of the baseplate, soleplate, or mounting block. Grout voids shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or mounting blocks. Grout voids shall be marked. At the discretion of the Engineer, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API 686.

3-4 FINAL INSPECTION: The Engineer will conduct a final inspection with the Contractor for conformance to requirements of the contract documents.

End of Section

SECTION 11005

MACHINE ALIGNMENT

PART 1 – GENERAL

1-1 DESCRIPTION This section specifies requirements for alignment of directly coupled mechanical equipment weighing 1000 pounds or more and/or greater than 100 horsepower furnished or modified under this contract. Equipment direct coupled to the motor with drivers 100 horsepower and less and belt or chain driven machinery are specifically exempted from the requirements of this section.

1-2 QUALITY ASSURANCE

1-2.01 GENERAL: All equipment shall be aligned using laser alignment equipment to the tolerances specified by the subject equipment manufacturer or the criteria specified in this section, whichever is more stringent.

1-2.02. ALIGNMENT CRITERIA: Unless otherwise specified by more stringent manufacturers' requirements, all mechanical equipment affected by this section shall be aligned to the following criteria:

Maximum Tolerable Misalignment

Speed, rpm, maximum	Short Couplings (Distance between flex planes ≤ 4")		Spacer Shafts angle at each flex plane in mils/inch or projected offset in mils/inch of spacer length
	Offset (mils)	Angularity (mils/inch)	
600 and less	5.0	1.0	1.8
900	3.0	0.7	1.2
1,200	2.5	0.5	0.9
1,800	2.0	0.3	0.6
3,600	1.0	0.2	0.3
7,200	0.5	0.1	0.15

Notes: (1) Soft foot (machine frame distortion) shall be not more than 2.0 mils for any speed.

(2) Separately mounted equipment connected by offset universal joints are exempted from the offset and angularity requirements, but all units must be installed and leveled as specified in this section.

1-2.03 ALIGNMENT EQUIPMENT: Alignment equipment used to perform the work required under this section shall employ laser alignment techniques to achieve the

required tolerances. The equipment shall be computer based and its software shall be compatible with current Windows® based spreadsheets and databases. The equipment shall employ a hand-held field computer using a graphic interface to determine actual alignment and necessary corrective action to bring equipment into required tolerance. The link between field measurement components and the computer shall be through cable, infrared, or wireless transmission.

1-3 REFERENCES. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1-3.01 Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
Shaft Alignment Handbook	Shaft Alignment Handbook, Third edition, John Piotrowski, Marcel Dekker Inc.

PART 2 - PRODUCTS

2-1 EQUIPMENT. Laser alignment equipment shall be Rotalign® Ultra as distributed by Ludeca, Inc., of Doral, Florida, or equal.

2-2 ITEMS TO BE FURNISHED TO OWNER. The following shall be furnished to the Owner upon completion of all alignment work for the project or appropriate portion thereof and prior to substantial completion of the project or portion thereof:

2-2.01 All alignment records, in both hard copy and in computer memory. The hard copy shall be signed and dated by the technician performing the alignment work and shall be witnessed by the Engineer.

PART 3—EXECUTION

3-1 GENERAL. After machine base grouting as specified under Section 11002, all machines mounted on base plates or soleplates specified above shall be aligned as specified under this section.

3-1.01 Alignment work shall be performed by journeyman millwrights skilled in this type of work under the supervision of a technician trained in the use of the laser alignment by the manufacturer or vendor of the alignment equipment. The use of untrained laborers, carpenters or apprentices for this work will not be acceptable.

3-2. PROCEDURE

3-2.01. SEQUENCE: Machines supported on integral feet or support pads shall be leveled, grouted and aligned in the following order: driven machine; intermediate bearings or machines; and driver. Under certain circumstances, such as a diesel engine driving a generator, it may be preferable to reverse this order and set the driver first. The Contractor shall submit a written request for a reversal of the alignment order to the Engineer and the Engineer must approve any change in alignment order in writing before it will be allowed.

3-2.02. ALIGNMENT: All machines shall be rough aligned without any connections to piping, electrical and instrumentation systems. Upon completion of all field connections, alignment shall be rechecked to demonstrate no change. If change has occurred, the Contractor shall eliminate any external forces affecting machine alignment.

3-2.03. Next, soft foot (machine frame distortion) shall be measured and brought to within the permissible tolerances (see paragraph 1.02 B, Note 1). Thereafter, the alignment shall be rechecked and the alignment process repeated if necessary to bring all machinery to final alignment tolerances.

3-3 VERIFICATION

3-3.01. FACTORY PERSONNEL: Where required by other sections in this project manual, factory authorized installation technicians representing the equipment manufacturer shall witness final alignment work. After completion of all alignment work, acceptance of the work shall be documented in writing by factory installation technicians.

3-3.02. VERIFICATION: All alignment work shall be independently checked using the shaft and coupling spool method described in the Shaft Alignment Handbook. All final results of the alignment work shall be subject to inspection and verification by the Engineer.

End of Section

SECTION 11020

VIBRATION AND CRITICAL SPEED LIMITATIONS

PART 1- GENERAL

1-1. DESCRIPTION. This section specifies vibration and critical speed limitations for rotating mechanical equipment. Factory and/or field testing and vibration measurements shall be taken when specified in the individual equipment specification sections.

1-2. VIBRATION LIMITATIONS

1-2.01 GENERAL: Vibration frequencies shall span the range from 5.0 to 5000 Hz. Where specified, measurements shall be obtained while the installed equipment is operating within the specified speed range.

1-2.02 CENTRIFUGAL: Machines with Sleeve Bearings: Unless otherwise specified, centrifugal machines with sleeve bearing shafts shall not exhibit unfiltered RMS readings for vibration displacement in excess of the following:

Shaft speed range, rpm	Displacement, peak to peak, mils
Up to 900	3.5
901-1800	3.0
1801-3000	2.5
3001-4500	2.0
Above 4500	1.6

Displacement measurements shall be taken radially on the shaft at two points at each bearing, except for well pumps which shall be measured at top of motor. Measuring points shall be 90 degrees apart.

Machines with Antifriction Bearings: Unless otherwise specified, centrifugal machines with antifriction bearing shafts shall not exhibit unfiltered RMS readings for vibration velocity in excess of 0.12 inch per second. Velocity measurements shall be taken on one point of each bearing housing.

1-2.03 POSITIVE DISPLACEMENT MACHINES: Unless otherwise specified, positive displacement machines of the rotary, reciprocating and controlled volume types shall

operate without any lateral or torsional vibration characteristics that may accelerate wear of the equipment. The Contractor shall provide manufacturer's certification that the manufacturer has inspected the machine under operating conditions and found it to comply with the requirements of this paragraph.

1-2.04. CRITICAL SPEED REQUIREMENTS. Unless otherwise specified, rotating mechanical equipment shall not exhibit critical speeds within the specified range of operating speeds. Critical speeds for equipment with rigid rotor systems shall be at least 20 percent greater than maximum operating speed. Critical speeds for equipment with flexible shaft rotor systems shall be at least 15 percent below minimum operating speed and 20 percent above maximum operating speed.

PART 2 - PRODUCTS

2-1. PRODUCT DATA: Manufacturer's certified data showing location of critical speeds in relation to operating speeds shall be provided as product data in accordance with the General Conditions.

PART 3 – EXECUTION (NOT USED)

End of Section

Section 11120

HORIZONTAL SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing and installation of two single-stage, horizontal, self-priming centrifugal wastewater pumping units, complete with all equipment and appurtenances specified herein.

The pumps shall be factory-mounted on a steel base complete with direct drives, electric motors, and other appurtenances specified or otherwise required for proper operation.

1-2. GENERAL. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section.

1-2.02. Power Supply. Power supply to equipment will be 480 volts, 60 Hz, 3 phase. Voltage tolerance shall be ±10 percent. Control voltage shall be 120 volts.

1-3. SUBMITTALS. Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the submittals section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps

- Type and model.
- Rotative speed.
- Size of suction nozzle.
- Size of discharge nozzle.
- Net weight of pump only.
- Net weight with base and all equipment mounted on the base.
- Complete performance curves showing capacity versus head, NPSH required, pump efficiency, and bhp.
- Reprime performance test data.
- Data on shop painting.

Motors

Name of manufacturer.
Type and model.
Type of bearings and method of lubrication.
Rated size of motor, hp.
Temperature rating.
Full load rotative speed.
Net weight.
Efficiency at full, 3/4, and 1/2 load.
Full load current.
Locked rotor current.
Space heater volts and watt ratings.
Motor electrical connection diagrams.

Adjustable Frequency Drives

As specified in the Adjustable Frequency Drives section.

1-4. SPARE PARTS. No spare parts shall be required.

1-5. WARRANTY. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

All equipment, apparatus, and parts furnished shall be fully warranted for a minimum of one year after final acceptance of Work by Owner, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

Components failing to perform as specified or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to Owner.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The pumping units serve as drain pumps for primary clarifiers, at a temperature of 55°F to 85°F, from the lower level of the primary headhouse to the existing preliminary treatment building.

2-2. PUMP MODELS. Pumps shall be Gorman-Rupp "Model T6A3-B", or equal.

2-3. PERFORMANCE AND DESIGN REQUIREMENTS. The pumping units shall be designed for the following operating conditions at maximum speed, unless otherwise noted:

Unit designations	PPS-11 and PPS-12
Number of units	2
Gorman-Rupp Model	T6A3-B
Total dynamic head, feet	75
Capacity at rated head, gpm	600
Total dynamic suction lift, feet	10
Operating head range at nominal pump operating speed, feet	20-100
Maximum (nominal) pump operating speed at rated head, rpm	1450
Maximum power required at input shaft of pump for any point in the operating head range, bhp	40
Minimum NPSH available at centerline of pump shaft, feet absolute	10
Maximum repriming lift, feet	23
Maximum static suction lift, feet	10
Total discharge static head, feet	20
Maximum starting frequency, starts/hour	8
Minimum pump nozzle size, inches	6
Suction	6
Discharge	6
Minimum test sphere diameter, inches	3
Minimum hydrostatic test pressure, psi	150

Pump performance shall be stable and free from cavitation throughout the specified operating head range at design suction submergences. The design performance shall be based on a wearing ring diametral or axial clearance of not less than 1 mil per inch of wearing ring diameter, or 12 mils total, whichever is greater.

2-4. FINISH. The pumps, piping, and exposed steel framework shall have a prime coat of a zinc base synthetic primer. The finish coat shall be automotive grade white acrylic enamel.

2-5. ACCESSORIES. Each pump shall be provided with lifting eyebolts or lugs; plugged gauge cock connections at the suction and discharge nozzles and tapped and plugged openings. The following accessory equipment shall also be provided.

2-5.01. Air Release Valves. Two automatic air release valves shall be provided for field

installation. The valves shall be of a design to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visible indication of valve closure and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable.

All valve parts exposed to sewage shall be constructed of cast iron, stainless steel, or similar corrosion-resistant materials. Diaphragms, if used, shall be of fabric-reinforced neoprene or similar inert material. A cleanout port, 3 inches or larger in diameter, shall be provided for ease of inspection, cleanout, and service. Valves shall be field-adjustable for varying discharge heads.

2-5.02. Gauge Kits. Each pump shall be provided with a glycerin-filled compound gauge to monitor suction pressures and a glycerin-filled pressure gauge to monitor discharge pressures. Gauges shall be a minimum of 4 inches in diameter and shall be graduated in feet water column. Rated accuracy shall be 1 percent of full-scale reading. Compound gauges shall be graduated -34 to +34 feet water column minimum.

Pressure gauges shall be graduated 0 to 140 feet water column minimum.

Gauges shall be mounted on a resilient panel and frame assembly which can be field-mounted to pumps or piping. Gauges shall be complete with all hoses and fittings and shall include a shutoff valve to be installed in each gauge inlet at the point of connection to suction and discharge pipes. All gauges shall be meet requirements of Section 17563.

2-5.03. Pump Drain Kits. Each pair of pumps shall be provided with a pump drain kit for field installation, consisting of a 10 foot length of plastic hose with a quick-disconnect female Kamlock fitting on one end of hose and two sets of fittings for pump drains. Each set of fittings for pump and drain includes a pipe nipple, bushing, bronze gate valve, and quick-connect male Kamlock fitting.

2-6. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 5.0 mils.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

2-7. DRIVE UNITS.

2-7.01. Electric Motors. The pump motors shall be per requirements of 16220 including constant speed, horizontal, totally enclosed, fan-cooled, induction type, with normal starting torque and low starting current characteristics. Motors shall be premium efficiency type and shall have a synchronous speed of 1,800 rpm. The motors shall not be overloaded at the design condition or at any head in the operating range as specified. Motors shall be provided with 120 volt, 1-phase space heaters.

2-7.02. Adjustable Frequency Drives. Adjustable frequency drives shall be provided and shall be coordinated with the requirements of the pumping unit. The pump manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

Adjustable frequency drives shall be designed as specified in the Adjustable Frequency Drives section.

2-7.03. Drive Transmission. Power shall be transmitted from motors to pumps by means of V-belt drive assemblies. The drive assemblies must be selected to establish proper pump speed to meet the specified operating conditions.
Each drive assembly shall have a minimum of two V-belts. Each V-belt drive assembly shall be selected on the basis that adequate power will be transmitted from driver to pump.

2-7.04. Belt Guards. Pump drive transmissions shall be enclosed on all sides in a guard constructed of any one or combination of materials consisting of expanded, perforated, or solid sheet metal, except that maximum perforated or expanded openings shall not exceed 1/2 inch.

Guards shall be manufactured to permit complete removal from the pump unit without interference with any unit component and shall be securely fastened to the unit base.

The guard shall be primed with a minimum of 1.5 mils of zinc-based synthetic primer. A finish acrylic enamel coating (minimum 1.5 mils) shall be applied in accordance with Section 3, Color Definitions of ANSI 253.1; 1967, Safety Color Code for Marking Physical Hazards.

2-8. Pressure Gauges. Gauge sizes and scale ranges for pressure, vacuum, or compound gauges shall be as indicated on the instrument device schedule drawings or as specified in accordance with requirements of 17563.

PART 3 - EXECUTION

3-1. SHOP TESTS.

3-1.01. Performance Tests. Each pumping unit shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall conform to the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be Level A, with no minus tolerance or margin allowed.
Each pumping unit should be tested with the drive unit to be installed in the work. If the pump is not tested with the drive unit to be installed in the work, wire-to-water efficiency shall be based on certified drive unit efficiency data. Certified drive unit efficiency data shall be included in the report.

If the pump fails to operate properly or fails to meet the specified conditions or requirements during testing, the pump manufacturer shall modify the pump and perform additional tests.

Five certified copies of a report covering each test shall be prepared by the pump manufacturer and delivered to Engineer not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, driver input and output power, pump and wire-to-water efficiency, rpm, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements, with all test points clearly shown. When the pump is not tested at the rated speed, performance charts shall include both the test speed and the calculated speed curves.

3-1.02. Reprime Tests. Each pumping unit shall be tested at the factory for the specified repriming lift at the selected speed and impeller diameter. Pump must reprime 12.0 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of pump suction centerline above liquid that the pump will prime within 5 minutes after a delivering pump is shut down with the suction check valve removed. Additional standards under which reprime tests shall be run are as follows:

- Piping shall incorporate a discharge valve downstream from the pump. Check valve size shall be equal (or greater than) the pump discharge diameter.

- A 10 foot length of 1 inch pipe shall be installed between pump and discharge check valve. This line shall be open to atmosphere at all times to duplicate the air displacement rate of a typical pumping station fitted with an air release valve.

- No restrictions shall be present in pump or suction piping which could serve to restrict the rate of siphon drop of the suction leg. Suction pipe

configuration for reprime test shall incorporate a minimum horizontal run of 4.5 feet and one 90 degree elbow.

- Impeller shall be set at the clearances recommended by the manufacturer in the pump service manual.

- Reprime lift repeatability shall be demonstrated by five sequential reprime cycles.

- Liquid to be used for the reprime test shall be water.

Reprime performance test data shall be submitted to Engineer prior to shipment.

3-2. TRAINING OF OWNER'S PERSONNEL. Manufacturer shall provide the Owner's personnel with a minimum of 8 hours' training in operation, troubleshooting, and maintenance of the pumping systems.

End of Section

Section 11134

SLUDGE GRINDERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of in-line sludge grinders to be installed on the suction side of the sludge transfer pumps (see section 11387) as noted in the following table:

Designation	Quantity	Tag numbers	Location
Primary Sludge Pump Grinders	Three (3)	GRD-20, GRD-30, GRD-40 (Additive Alternative)	SRWRC Primary Headhouse

Each grinder shall be complete with vertically mounted drive unit, control panel, anchor bolts, and all other appurtenances specified or otherwise required for proper operation.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer. The grinder shall be furnished complete with all control equipment, accessories, and appurtenances specified, indicated on the drawings, or otherwise required for a complete, properly operating installation.

1-3.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-3.02. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1-3.03. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-3.04. Permanent Nameplates. Each grinder denoted by an identifying code and number in the Specifications or on the Drawings shall be provided with permanent nameplates. Identification used shall be the same as the identifying code and number indicated in the Specifications or on the Drawings. Permanent nameplates shall be 16 gauge stainless steel identification plate which shall be securely mounted on each

grinder in a readily visible location. The plate shall bear the ¼ inch die stamped equipment identification numbers that are assigned herein and shown on the Drawings.

1-3.05. Information Plates. Each major component of equipment shall have an information plate securely affixed to the equipment. Information plates shall be as specified in the Equipment and Valve Identification section.

1-3.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; materials, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Each manufacturer of major equipment shall have a local service center, or with written consent of the Engineer, shall be able to provide service from other locations with 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

1-4. SUBMITTALS.

1-4.01. Drawings and Data. Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering material used, drive unit, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Grinders

Manufacturer.
Type and model.
Speed at rated condition.
Size of suction flange.
Size of discharge flange.
Net weight of grinder and baseplate.
Base and anchor bolts details.
Type, size, and manufacturer of bearings.

Motors. As specified in the Common Motor Requirements for Process Equipment section.

Controls. Panel fabrication and arrangement drawings shall be in accordance with all applicable provisions of 17500, including 17570 and 17561.

Panel component Bill of Materials and manufacturer's Data Sheets.
Interconnection and schematic diagrams.

Sequence of Operation. A recommended sequence of operation including valves and ranges for time delays, speeds, and other set points.

The following specific information shall be included with each submittal: a copy of the specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will denote compliance to the specifications. The submittal shall be accompanied with a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, shall be rejected with no further consideration.

In addition, a copy of any contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in the submitted section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

The submittal shall also include the following:

Control panel descriptive literature and schematic control diagrams.

Power wiring diagrams for each type.

Manufacturers written certification that the factory applied coating system(s) is identical to the requirements specified herein. Where, in the manufacturer's opinion, the coating system(s) exceeds requirements specified herein, submit complete technical literature of the proposed system(s) to the Engineer for review.

Relevant experience references.

Manufacturer's certification.

Manufacturer's data.

Operation and maintenance manuals.

Warranty information and certification. Manufacturer shall also include information on preventative and routine maintenance requirement as well as documentation requirements necessary to maintain the equipment warranty.

1-4.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied and shall be submitted in accordance with Submittal Procedures section. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

A. Equipment function, normal operating characteristics, and limiting conditions.
B. Assembly, installation, alignment, adjustment, and checking instructions.
C. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.
D. Lubrication and maintenance instruction.
E. Guide to troubleshooting.
F. Parts list and predicted life of parts subject to wear.
G. Outline, cross-section, and assembly drawing; Engineering data; and wiring diagrams.
H. Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instruction or parts lists packed with or attached to the equipment when delivered.

1-5. QUALITY ASSURANCE.

1-5.01. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including the motor, shall not exceed the maximum vibration limits of the governing standard unless otherwise required.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing: NEC, National Electrical Code, NEMA, National Electrical Manufacturers Association, OSHA, Occupational Safety and Health Act., ANSI, American National Standards Institute, ASTM, American Society for Testing Materials, AISI, American Iron and Steel Institute, AGMA, American Gear Manufacturer's Association, and AFBMA, Anti-Friction Bearing Manufacturer's Association.

1-6. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-7. SPARE PARTS.

1-7.01 Parts. The following spare parts and accessories shall be furnished for each size grinder with a cast iron body in substantial wooden boxes with identifying labels and delivered to the vicinity of the Project Site, as follows:

Spare Parts	Quantity
Sets of oil seals	4 each size
Cutters	2 sets each size
Spacers	4 sets each size
Gaskets and O-ring sets	4 sets each size
Bearing assemblies	4 sets each size
Seal cartridge assemblies, including bearings and mechanical seals	4 each size
Complete set of keys dowels and pins	2 each size
Special tools required to maintain or dismantle the grinders	1 set

1-7.02 Spare Grinder. Provide two fully assembled units flange to flange with motor as shelf spare. Spare grinders shall be the same make, model and type; and serve as the drop-in replacement for the primary sludge grinders specified in this section.

1-8. Acceptable Manufacturers. Grinders shall be Muffin Monster as supplied by JWC Environmental, Model 30004T-1206 as manufactured by Disposable Waste Systems, Inc., Moyno Annihilator, Franklin Miller Taskmaster, or equal.

The manufacturer shall review the mechanical layout drawings to familiarize themselves with the location and set-up of the equipment specified and shall assure themselves that the equipment specified is appropriate for and coordinated with what is shown on the contract drawings.
Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be

considered as being included in the price bid for the work shown and specified. The manufacturer shall also review the relevant electrical plan and one-line diagram and the relevant process and instrumentation diagram drawings to ensure that the contract drawings are appropriate and coordinated with the equipment controls specified and the monitoring and protection devices shown on the P&ID.

The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation for a minimum period of 5 years. Provide a list of such installations with installation description, contact names, addresses and telephone numbers.

The Contractor shall assign unit responsibility to the grinder manufacturer for the equipment specified in this section. A certificate of unit responsibility shall be provided as part of the equipment submittals.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The grinders shall operate as follows:

Primary Sludge Pumps – The units shall operate on the suction side of primary sludge pumps, one grinder per set of two sludge pumps.

Each in-line grinder shall have a rotating shaft and shall be used to reduce particle size of the sludge.

The equipment will be installed in the in-line configuration in a horizontal pipeline as indicated on the Drawings. Inlet and outlet connections to the equipment shall be flanged. The motor shall be mounted in a vertical position directly above the pipeline.

The grinders will be located at a wastewater treatment plant where frequent wash downs can be expected. The temperature of the waste material is expected to vary between 50 degrees F and 95 degrees F, and pH is expected to range between 6 and 8. Grinders will be subjected to ambient temperature range of 40F to 100F and up to 90% relative humidity.

The equipment shall be capable of continuous operation with or without the liquid flow passing through it and shall operate without an external source of water for flushing seals or cutter blades. The design shall also permit removal and replacement of internal rotating parts without removing the grinder side housings or disconnecting the flanges from the piping system.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The grinders shall be designed for operating conditions listed in the Grinder Data Sheets and as defined herein.

All specified conditions shall be at rated speed unless otherwise indicated. Parts shall be interchangeable between units of similar size and capacity to extent practical.

The grinder shall be designed to be installed as shown in a process pipeline to continuously macerate primary sludge, scum and waste activated sludge (WAS) from a wastewater treatment plant. Solids to be encountered during operation of the grinders are those typically found in wastewater and include heterogeneous mixtures of organic and inorganic material. Concentrations of solids are expected to range up to 7 percent. Organic solids include fecal material, vegetable parts, rubber goods, plastics, paper products, bones, small chunks of wood and semi-solid grease particles. Inorganic solids will include rocks, sand, and metal pieces of various sizes and composition. The liquid is expected to contain oil, grease, petroleum products, solvents, and water.

Grinder	Equipment Numbers GRD-20, GRD-30, GRD-40 (Additive Alternate)
Cutting chamber height, inches	28
Pipe size, inches	6
Rated capacity, gpm	150
Maximum pressure loss at rated flow, feet	1
Cutter teeth Assembly, number	2
Cutter tooth:	7
Height, inches, minimum	8
Root diameter overlap, inches	1/8”
Motor	
Horsepower, maximum	5
Type	TEFC
Power	3 Ph 460 V
	1,760 RPM

2-3. MATERIALS. Each unit shall be constructed of the following materials as required.

Body	Cast iron
Shafts	AISI 4140 heat treated steel
Cutters	Cutters and spacers shall be 8620 alloy steel hardened to a minimum 45-50 Rockwell "C" and ground for uniformity. Combination cutter/spacers will not be acceptable. The number of cutters shall be as recommended by the manu-facturer.
Seals	Mechanical seals with tungsten carbide faces or neoprene V-ring seal with stainless steel grit check

2-4. GRINDER CONSTRUCTION. Grinder shall be motor driven dual-shaft type with vertical motor. Grinder shall be rated for continuous duty for the application of continuous grinding of typical primary sludge and waste activated sludge solids at a wastewater treatment plant. Grinder shall be rated for severe-duty and shall have very high abrasion resistance. The space between the rotating cutters and the cutting chamber sidewalls shall avoid short-circuiting of the cutting elements.

Two-shaft design shall consist of two parallel shafts alternately stacked with individual intermeshing cutters and spacers cutters positioned on the shaft to form a helical pattern. The shafts shall counter-rotate with the idler shaft operating at approximately two-thirds (2/3) the speed of the drive shaft.

The grinder body shall have a flanged cleanout handhole. Inlet and outlet of the grinder shall not be less than the nominal size of suction and discharge pipe.

The grinder shall be provided with flanged inlet and outlet connections, ASTM A536-84 ductile iron, or stainless steel, with Class 125 drilling. The grinder shall be designed for a hydrostatic pressure of 60 psi without leaking.

The grinder shall be driven by a direct driven gear reducer assembled as an integral part of the equipment and shall be equipped with mechanical seals with silicone carbide face materials. Seals shall require no external water source. The grinder bearings shall be ball bearings. Shaft radial and axial loads shall be borne by four sealed oversize Conrad-type ball bearings, which will be rated by the bearing manufacturer with a minimum basic dynamic load rating of 7050 pounds. The bearings will be protected against the intrusion of any foreign particles by a combination of a tortuous path device and end-face mechanical seals. Face materials must be a minimum of tungsten carbide

to tungsten carbide, not requiring an external flush. The mechanical seal will be rated at 60 psi continuous duty by the manufacturer. Bearings and seals shall be housed in a replaceable cartridge.

The grinder shall be provided with grease lubricated sleeve, ball, or ball and roller type bearings. The bearings and seals shall be housed in replaceable wear sleeves.

Grinder speed reducers shall be planetary gear reducers with a speed reduction ratio of 29:1, an applied service factor of 1.2, and a "Heavy Shock" load classification.

The grinder shall be provided with lifting eyebolts or lugs.
Two shafts shall counter-rotate with the driven shaft operating at approximately 66 percent of the speed of the drive shaft.

Intermeshing cutters and spacers shall be composed of 4130 steel and through-hardened Rockwell 45-50 C surface ground steel. The cutters shall be self-cleaning. The cutters shall be of the seven tooth design with two leading cutting edges on each tooth so as to cut in each direction without removing the cutters from the grinder. Grinder design shall include cutter bar design that can also be turned upside down and reused when worn on one side while maintaining the same direction of flow. Cutters shall be arranged in a stack such that it forms a reversible cartridge which can be pulled out from the grinder body and turned upside down and inserted back in the grinder.

2-5. DRIVE UNITS.

2-5.01. Electric Motors. Motors shall comply with the Common Motor Requirements for Process Equipment section except as specified herein. Motors shall be vertical, squirrel-cage induction-type rated 460 volts, three phase, 60 hertz, with planetary-type speed reducer.

Motors shall be provided with a totally enclosed, fan-cooled enclosure with special corrosion-resistant finish and encapsulated windings meeting the requirements of NEMA MG1-1.27.1. Motors shall have a 1.15 service factor.

Motors shall be provided with a motor space heater rated 120 volts ac.

2-5.02. Couplings. The high speed shaft of the grinder, reducer, and motor shall be directly coupled with each other using two- and three-piece couplings.

2-6. CONTROL PANEL.

2-6.01. General. The grinders shall be furnished with NEMA 4X 316 stainless steel control panels complete with full-voltage reversing starter. Panels shall meet the requirements specified in the Control Panels and Enclosures section 17570 and the Instrumentation and Control System section 17500. Panel-mounted components,

including selector switches, indicating lights, push buttons, and power supplies shall meet the requirements specified in Section 17561. Each motor controller shall utilize a solid state logic design with line transient protection to 1,000 volts. A control transformer shall supply all low and intermediate control voltage. All transformer legs shall be fuse protected. The control transformer shall be provided by the grinder manufacturer within the controller enclosure. The controller shall provide thermal motor overload utilizing a solid-state motor overload relay and single-phase protection.

2-6.02. Function. The control panel shall provide the following functions:

a. Main disconnect: Circuit breaker rated 600 volt, 3 pole, with an interrupting rating of 42,000 ampere at 480 volt with trip-indication and padlockable "off" external handle.

b. LOCAL-OFF-REMOTE (LOR) selector switch. In the OFF position, the electrical motor shall not run. In the LOCAL position, the panel controls are used and the motor shall run. In the REMOTE position, the grinder shall start and stop based on a remote run command and as described herein to clear jams/overloads.

c. A FORWARD- REVERSE (FR) automatic spring return selector switch and/or pushbuttons shall be provided on the panel face. When the LOR selector switch is in the LOCAL position and the FR selector switch is in the FORWARD position, the grinder rotation shall run normally. In the REVERSE position, the grinder shall reverse its rotation until the switch/button is released.

d. A Reset push button that clears all alarms. All alarms shall remain latched until the Reset push button is pressed.

e. An emergency stop mushroom head push button.

f. A motor elapsed time meter.

g. Push-to-test pilot lights indicating “Running” and “Fail” statuses. Light colors shall be ‘RED’ for ‘Running’ and ‘GREEN’ for ‘OFF’ Status. ‘FAIL’ status shall be ‘AMBER’. All miscellaneous ‘Status’ lights (not indicating an alarm condition) shall be ‘WHITE’.

h. Each grinder control panel shall have normally closed contacts rated 10 A at 120 VAC for remote indication of “Running,” “In Remote,” and “Fail” statuses.

i. Each grinder control panel shall have two (2) normally closed Pump Run Permissive contacts rated 10 A at 120 VAC. When the grinder is not

running or under a grinder jam or overload condition, as described herein, these Pump Run Permissive contacts shall open.

j. Overload protection.

Jam or overload protection.

(1) Upon the grinder encountering a jam or overload condition, the controller shall stop the grinder and reverse its rotation to clear the obstruction. If the jam is cleared, the controller shall return to normal operation. If the jam condition still exists, the controller shall go through two additional reversing cycles within 30 seconds (3 times total) before signaling a grinder overload condition. Upon a grinder overload condition, the controller shall shut off the grinder and activate the Fail alarm circuits.

(2) Upon a grinder overload condition, the controller shall also shut off the pumps by removing the pump run permissive signals from each pump.

K. Provide the following external interfaces.

- Grinder OVERLOAD (Fail).
- Grinder RUNNING (3 SPDT contacts).
- Grinder remote RUN command.
- Grinder in REMOTE position.
- Grinder E-Stop pressed.
- Grinder remote RESET command.

Discrete outputs shall be isolated SPDT contacts rated for 5 amps continuous at 120V ac, minimum. Discrete inputs shall be isolated contact closure rated at 2 amps continuous at 120 mV ac.

2-7. SHOP PAINTING. Ferrous metal surfaces of each unit shall be coated with universal primer and finish coated. The manufacturer's standard coating will be acceptable, provided it is functionally equivalent to or exceeds the specified coatings specified in Protective Coatings section and is compatible with the specified field painting. Prior to coating, surfaces shall be thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

Finish color shall be as selected by the Owner and the Engineer during the submittal review process.

2-8. WARRANTY.

2-8.01 Standard Warranty. Contractor shall provide a one year standard warranty in accordance with the General Conditions against defective equipment and poor workmanship.

2-8.02 Extended Limited Warranty. Contractor shall also provide the Owner with an extended limited warranty for the grinders including the motors, controls and seals provided as part of this Section with respect to the specified performance criteria. The warranty shall bind the equipment manufacturer or the unit responsibility supplier for the equipment specified in this section and shall be backed by a performance and maintenance bond in the amount of 100 percent of the cost of the equipment. An irrevocable letter of credit, drawn on a U.S. government-insured banking institution, may be substituted for the specified bond. The warranty must be supplied to the Owner by the Contractor prior to start-up of the equipment and must be in a form acceptable to the Owner. The warranty shall be limited to all direct costs, including labor, and consequential costs relating to any required remedy, including replacement of the equipment, associated with failure of the equipment to perform as specified, consistent clogging and torque cutoff of the grinders, premature failure of the bearings, seals and / or cutting bars during the warranty period. The warranty shall cover the period during initial start-up and testing and from the date of expiration of the Contractor's standard one year warranty for a period of 1460 days to allow for evaluation of equipment life and structural integrity over a period of 5 years

PART 3 - EXECUTION

3-1. INSTALLATION. Each grinder shall be installed where indicated on the Drawings. The grinder shall be totally supported by the structure and shall not impart any load on the connecting piping.

Couplings will be realigned after grouting. Final coupling misalignment will be within one-half of the coupling manufacturer's allowable tolerance.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the Site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Testing, Training, and Facility Start-up section, and shall revisit the job Site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been

operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-2.02. Installation Supervision. A technically qualified manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum person-days listed for the services herein under, travel time excluded:

- 2 man days for installation assistance, inspection, and written certification of the installation.
- 2 man days for functional testing and training of City personnel.

3-3. TRAINING. Training by the manufacturer is required. Startup services and training of City personnel shall be in accordance with the specifications and at such time as requested by the Owner.

End of Section

Section 11185

SUBMERSIBLE SUMP AND SEWAGE PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of medium and heavy duty single-stage, submersible, end suction centrifugal pumping units and controls for clear water (sump) and sewage service as specified and as indicated in the Sump and Sewage Pump Schedule on the Drawings for permanent installation. Each pump shall be guiderail or pedestal-mounted as indicated in the schedule. This section also covers the furnishing of portable submersible sump pumps to be used at various locations.

Piping, pipe supports, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

Each pumping unit shall be complete with a close-coupled, submersible electric motor; controls; and all other appurtenances specified or otherwise required for proper operation.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, materials, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size,

functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Power Supply. Power supply to equipment will be as indicated in the Sump and Sewage Pump Schedule.

1-2.05. Mechanical Identification. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1-2.06. Manufacturer. Pumps shall be Weil, Model 1622, or equal.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps
- Name of manufacturer.
- Type and model.
- Rotative speed.
- Size and type of pump discharge connection.
- Net weight of pump and motor only.
- Complete performance curves showing capacity versus head, bhp [brake kW], NPSH required, and efficiency.
- Seal type and manufacturer.
- Data on shop painting.

Motors
- Name of manufacturer.
- Type and model.
- Type of bearings and method of lubrication.
- Rated size of motor, hp [kW].
- Full load current.
- Locked rotor current.

Control Panel and Components
- Name of manufacturer.
- Type and model.
- Dimensions and net weight of complete panel.
- Pump control sequence.
- Liquid level sensors with mounting details and cable lengths, and sump controls.
- Wiring diagrams.
- Power and control cable type and size.

Accessories
- Sump Cover
  - Material, thickness, and finish.
  - Overall dimensions.
  - Opening locations and dimensions.
- Guiderail System
  - Materials.
  - Dimensions.

Seismic Design Requirements
- Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operations and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-5. EXTRA MATERIALS. A complete set of seals, O-rings, and gaskets, and one spare set of mechanical seals shall be furnished for each type and size of pump provided.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Unless otherwise indicated in the schedules, sump pumps shall be suitable for pumping clear water with minimal solids of 3/16 inch [5 mm] diameter or less, and sewage pumps shall be suitable for pumping sanitary waste and sludge and shall pass a 2 inch [50 mm] sphere. The maximum pumped liquid temperature shall be 85°F [29°C].

Portable sump pump shall be suitable for pumping 3/8" solids.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Pumping units shall be designed for the operating conditions and requirements indicated in the Sump and Sewage Pumps Schedule.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. Minimum pump hydrostatic test pressure shall be 1.5 times the pump shutoff head. Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.

Where indicated on the Sump and Sewage Pump Schedule to be explosion proof, pumping units shall be rated and labeled for use in a Class I, Division 1 or 2, Group D area, as defined by the National Electric Code. The division shall be as indicated in the schedule.

2-3. MATERIALS.

Stator Housing and Pump Casing	Cast iron, ASTM A48.
Impeller	
Medium Duty Sump Pumps	Bronze
Heavy Duty Sump Pumps	Cast Iron
Sewage Pumps	Cast Iron
Shaft	Stainless steel, AISI Type 316.
All Wetted Assembly Fasteners	Stainless steel.
Mechanical Seals	
Medium Duty Pumps	Single type, with ceramic and carbon seal faces.
Heavy Duty Pumps	Double mechanical opposed type,Tandem mechanical type, oil lubricated with carbon/ceramic upper

	seal and silicon carbide lower seal.
Pedestal Base	Cast iron.
Epoxy Coating	
Primer & Finish Coat	Carboline "Carboguard 891" or Tnemec "Series N140 Pota-Pox Plus".

2-4. PUMP CONSTRUCTION.

2-4.01. Impeller Casing. The impeller casing shall have well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities. Guiderail mounted pumps shall be provided with a flanged discharge nozzle sufficiently rigid to support the pumping unit under all operating conditions. Pedestal mounted pumps shall be provided with a threaded or compression discharge connection. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT.

2-4.02. Impeller. The impeller shall be a semiopen or enclosed one-piece casting. Sewage pump impellers shall not have more than two nonclog passages. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced and securely locked to the shaft by means of a key and self-locking bolt or nut.

2-4.03. Seal Chamber. Each heavy duty pumping unit shall be provided with an oil-filled chamber for seal lubrication. The chamber shall contain a moisture sensor and shall be provided with a fill/drain plug.

2-4.04. Sealing of Mating Surfaces. All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is required. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

2-4.05. Guiderail Removal System. Where indicated on the Sump and Sewage Pump Schedule, pumping units shall be provided with a guiderail removal system. The removal system shall be provided with a discharge base, sliding bracket, guiderails, fasteners, and all other accessories indicated or required for a complete system.

2-4.05.01. Discharge Base. The discharge base shall be sufficiently rigid to firmly support the guiderails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the sump. The face of the discharge elbow inlet flange shall be perpendicular to the floor and shall make contact with the face of the pump

discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ANSI B16.1, Class 125.

The pump and motor assembly shall be automatically connected to and supported by the discharge base and guiderails so that the unit can be removed and replaced without the need for operating personnel to enter the sump.

2-4.05.02. Sliding Bracket. The sliding bracket shall be self-aligning type. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions. Where the pump is indicated in the Sump and Sewage Pump Schedule to be explosionproof, the guiderail sliding bracket shall be constructed of nonsparking materials.

2-4.05.03. Guiderails. Guiderails shall be sized to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to the access hatch cover at the top of the sump. Guiderails shall be stainless steel pipe, ASTM A312, Schedule 40S. An upper guiderail bracket of AISI Type 304 stainless steel shall be provided.

2-4.06. Lifting Chain. Where indicated in the Sump and Sewage Pump Schedule, stainless steel chain or cable suitable for removing and installing each pumping unit shall be selected and provided by the pump manufacturer. The chain or cable shall be rated for at least four times the weight of the pumping unit and shall be of adequate length to reach five feet above the sump cover with the pumping unit in the normal operational position.

2-4.07. Sump Cover. Where indicated in the Sump and Sewage Pump Schedule, a sump cover shall be furnished by the pump manufacturer. The cover shall be hot dipped galvanized steel at least 3/8 inch thick or aluminum at least 1/2 inch thick. Openings in the sump cover shall be provided for vent piping, pump discharge piping, controls, and electrical cables. Opening dimensions and cover size shall be as needed to suit the equipment furnished and the sump dimensions indicated on the Drawings. An inspection opening with bolted cover shall be provided. The opening shall be at least 12 inches [300 mm] by 8 inches [200 mm]. All openings shall be gasketed gas-tight.

The sump cover of pedestal mounted pumping units shall be provided with a bolted and gasketed floor plate for each pumping unit. The floor plate shall be adequate in size to allow removal of a single pumping unit with attached discharge piping. The floor plate shall be galvanized or epoxy coated steel and shall be at least 1/4 inch [6 mm] thick.

Pumping units with guiderail removal systems shall be provided with a hinged access hatch mounted on the sump cover. The access hatch shall be adequate in size to

remove each pumping unit with the guiderail system. The hatch shall be provided with two hinges, handle, and padlock hasp. The hatch shall be gasketed as needed to be gas-tight.

Each cover shall be provided with a lifting chain hook and a support bracket for the level control float cables.

2-5. FABRICATION AND MANUFACTURE.

2-5.01. Shop Painting. All iron and steel parts of heavy duty pumping units which will be in contact with pumped liquid or submerged after installation, including the inside of the casing, the impeller, and the discharge elbow, shall be shop cleaned in accordance with the coating manufacturer's recommendations and painted with an epoxy coating system. The coating shall have a dry film thickness of at least 10 mils [250 µm] and shall consist of a prime (first) coat and one or more finish coats. At least 1 quart [1 L] of the finish coat material shall be furnished with each pump for field touchup.

2-6. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 4 mils [100 µm] for pumping units with a nominal rotative speed of 1500 rpm or greater, 5 mils [125 µm] for pumping units with a nominal rotative speed less than 1500 rpm and greater than 900 rpm, or 6 mils [150 µm] for pumping units with a nominal rotative speed of 900 rpm or less.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

2-7. MOTORS.

2-7.01. Motors. Pumps shall be driven by an air-filled, totally submersible electric motor manufactured by the pump manufacturer. Motors shall have a minimum service factor of 1.05. Motor nameplate rating shall exceed the maximum horsepower [kW] required by the pump in an operating head range 20 percent above or below the design point. The stator housing shall be an air-filled, watertight casing. Motor insulation shall be moisture resistant, Class F, 155°C. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature, and designed for at least 10 starts per hour.

120 volt motors shall be provided with integral auto-reset thermal overload protection.

Motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The

bearings shall have a calculated AFBMA L_{10} Life Rating of 40,000 hours when operating at maximum operating head. Maximum shaft runout at the mechanical seals shall not exceed 2 mils [50 µm] at any point in the operating head range.

Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. Cable sizing shall conform to NEC requirements. With the exception of 120 volt units, all cables shall be of sufficient length to terminate in a junction box or control panel outside the sump as indicated on the Drawings, with 10 feet [3 m] of slack which will be coiled in the sump. Power and control cables for 120 volt units shall be of sufficient length to reach the power supply receptacle or junction box as indicated on the Drawings with 5 feet [1.5 m] of slack. Each cable shall be supported by AISI Series 300 corrosion-resistant stainless steel Kellems or woven grips to prevent damage to the cable insulation. Mounting of cable supports in the sump shall be coordinated by the supplier to prevent damage to the cable.

The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

The motor and its integral protective controls shall be rated and labeled for use in an exposure classification similar to that of the pump, under both submerged and unsubmerged conditions.

2-8. CONTROLS. Each pumping unit shall be provided with a complete control system as indicated herein. The control system type shall be as indicated in the Sump and Sewage Pump Schedule.

2-8.01. Simplex Piggyback Control. Simplex piggyback control systems shall consist of a weighted ball float assembly with an integral differential switch, control cord with piggyback plug, and mounting hardware. The plug shall be suitable for connection into a standard 120 volt receptacle, and shall accept a 120 volt plug from the pumping unit. Differential switches shall be single pole and rated for at least 1.0 hp [0.75 kW] at 120 volts. The control cable shall be suitable for submerged service and shall be rated for at least 15 amps. The mounting hardware shall be suitable for attachment to the pump discharge piping, and shall be constructed of corrosion resistant materials. The control system shall automatically energize and de-energize the pumping unit as the sump water level rises and falls. The control system shall be Weil "Model 8245".

2-8.02. Medium Duty Simplex Control System. Medium duty simplex control systems shall consist of a control cabinet and sump level sensors for control of medium duty simplex pumping systems.

2-8.02.01. Control Cabinet. The control cabinet for the pump shall include all controls specified herein or required for a properly operating system. The cabinet shall include the following features:

NEMA Type 4X metallic enclosure.

NEMA rated combination magnetic motor starter with motor circuit protector and manually reset bimetallic ambient compensated overload relay.

Control power transformer with both primary leads fused and one secondary lead fused. One secondary lead shall be grounded.

Ground terminal, control relays, numbered and wired terminal strip.

One 3 position “Test-Off-Automatic” selector switch for pump operation. Selector switch shall be spring return from Test to Off position. In “Test” position the pump shall run, in “Off” position the pump shall be off, in “Automatic” position the pumps shall run as specified in the control sequence paragraph.

One high water alarm “Test-Auto-Silence” switch when high water alarm is specified in the Sump and Sewage Pump Schedule. Switch shall be spring return from Test and Silence position to Auto position.

One high water audible alarm horn and silence pushbutton and alarm light when high water alarm is specified in the Sump and Sewage Pump Schedule. Alarm horn shall be 4 inch 95 dB and shall be mounted on the bottom of the cabinet. Alarm light shall be a red flashing light mounted on top of the cabinet.

Red running light, white control power on light, red motor overload light.

Elapsed time meter.

Two isolated dry type contacts for high water alarm, one isolated dry type contact for motor overload.

One alarm reset pushbutton. This button shall reset all alarm contacts. Alarm lights shall stay illuminated until the alarm condition is cleared.

2-8.02.02. Liquid Level Sensors. Liquid level sensors consisting of an assembly of weighted ball floats with integral switches shall be furnished by the pump manufacturer. The sensors shall be suitable for simplex pump operation with high water alarm and shall be Weil "8230 Series". Each system of sensors shall be furnished complete with all required mounting brackets, weights, galvanized steel mounting pipes and accessories, control power transformers, auxiliary relays, cables, and junction boxes.

2-8.02.03. Control Sequence. Upon an increase in sump liquid level, the pump shall be energized. If the liquid level continues to rise, the high water alarm light located on the face of the pump control panel shall be illuminated, an audible alarm shall be sounded, and the isolated alarm contact shall close. As the sump liquid level decreases to the "Pumps Off" setpoint, the pump shall be de-energized. Sump liquid level setpoints shall be as indicated in the Sump and Sewage Pump Schedule.

2-8.03. Heavy Duty Simplex Control System. Heavy duty simplex control systems shall consist of a control cabinet and sump level sensors for control of heavy duty simplex pumping systems.

2-8.03.01. Control Cabinet. The control cabinet shall include for each pump all controls specified herein or required for a properly operating system. The cabinet shall include the following features:

NEMA Type 4X metallic enclosure.

One NEMA rated combination magnetic motor starter with motor circuit protector and manually reset bimetallic ambient compensated overload relay.

Control power transformer with both primary leads fused and one secondary lead fused. One secondary lead shall be grounded.

Ground terminal, control relays, numbered and wired terminal strip.

One 3 position “Test-Off-Automatic” selector switch for pump operation. Selector switch shall be spring return from Test to Off position. In “Test” position the pump shall run, in “Off” position the pump shall be off, in “Automatic” position the pumps shall run as specified in the control sequence paragraph.

One high water alarm “Test-Auto-Silence” switch when high water alarm is specified in the Sump and Sewage Pump Schedule. Switch shall be spring return from Test and Silence position to Auto position.

One high water audible alarm horn and silence pushbutton and alarm light when high water alarm is specified in the Sump and Sewage Pump Schedule. Alarm horn shall be 4 inch 95 dB and shall be mounted on the bottom of the cabinet. Alarm light shall be a red flashing light mounted on top of the cabinet.

Red running light, white control power on light, red motor overload light.

Elapsed time meter.

Two isolated dry type contacts for high water alarm, one common isolated dry type contact for motor overload, motor high temperature, and moisture detected.

One alarm reset pushbutton. This button shall reset all alarm contacts.

Alarm lights shall stay illuminated until the alarm condition is cleared.

2-8.03.02. Motor Protection. Each motor of heavy duty pumping units shall be protected by temperature switches mounted in each phase winding and designed to operate at 140°C ±5°C. The oil-filled seal chamber shall be provided with a moisture detection system furnished by the pump manufacturer, complete with all sensors, cables, control power transformers, auxiliary relays, and junction boxes. Motor protection controls shall be mounted inside the control cabinet. The temperature switches and moisture detection system shall be provided with a manual reset for explosionproof pumps and automatic reset for non-explosionproof pumps.

2-8.03.03. Liquid Level Sensors. Liquid level sensors consisting of an assembly of weighted ball floats with integral switches shall be furnished by the pump manufacturer. The sensors shall be suitable for simplex pump operation with high water alarm and shall be Weil "8230 Series". Each system of sensors shall be furnished complete with all required mounting brackets, weights, galvanized steel mounting pipes and accessories, control power transformers, auxiliary relays, cables, and junction boxes.

2-8.03.04. Control Sequence. Upon an increase in sump liquid level, the pump shall be energized. If the liquid level continues to rise, the high water alarm light located on the face of the pump control panel shall be illuminated, an audible alarm shall be sounded, and the isolated alarm contact shall close. As the sump liquid level decreases to the "Pumps Off" setpoint, the pump shall be de-energized. Sump liquid level setpoints shall be as indicated in the Sump and Sewage Pump Schedule. In the event that moisture is detected in the seal chamber or if high motor temperature is detected, the respective alarm light located on the face of the control panel shall be illuminated and the pump shall be de-energized.

2-8.04. Medium Duty Duplex Control System. Medium duty duplex control systems shall consist of a control cabinet and sump level sensors for control of medium duty duplex pumping systems.

2-8.04.01. Control Cabinet. The control cabinet shall include for each pump all controls specified herein or required for a properly operating system. The cabinet shall include the following features:

NEMA Type 4X metallic enclosure.

One main thermal magnetic circuit breaker disconnect with external lockable operating handle.

Two NEMA rated combination magnetic motor starters with motor circuit protector and manually reset bimetallic ambient compensated overload relays.

One pump alternator.

Two control power transformers with both primary leads fused and one secondary lead fused. One secondary lead shall be grounded.

Independent control power circuit for each pump. Control power circuits shall be interlocked such that one control power circuit serves as a backup to the other control power circuit.

Ground terminal, control relays, numbered and wired terminal strip.

Two 3 position “Test-Off-Automatic” selector switch for pump operation. Selector switch shall be spring return from Test to Off position. In “Test” position the pump shall run, in “Off” position the pump shall be off, in “Automatic” position the pumps shall run as specified in the control sequence paragraph.

One high water alarm “Test-Auto-Silence” switch when high water alarm is specified in the Sump and Sewage Pump Schedule. Switch shall be spring return from Test and Silence position to Auto position.

One high water audible alarm horn and silence pushbutton and alarm light when high water alarm is specified in the Sump and Sewage Pump Schedule. Alarm horn shall be 4 inch 95 dB and shall be mounted on the bottom of the cabinet. Alarm light shall be a red flashing light mounted on top of the cabinet.

Two red running lights, two white control power on lights, two red motor overload lights.

Two elapsed time meters.

Two isolated dry type contacts for high water alarm, one common isolated dry type contact for motor overload.

One alarm reset pushbutton. This button shall reset all alarm contacts. Alarm lights shall stay illuminated until the alarm condition is cleared.

2-8.04.02. Liquid Level Sensors. Liquid level sensors consisting of an assembly of weighted ball floats with integral switches shall be furnished by the pump manufacturer. The sensors shall be suitable for duplex pump operation with high water alarm and shall be Weil "8230 Series". Each system of sensors shall be furnished complete with all required mounting brackets, weights, galvanized steel mounting pipes and accessories, control power transformers, auxiliary relays, cables, and junction boxes.

2-8.04.03. Control Sequence. Upon an increase in sump liquid level, the lead pump shall be energized. If the liquid level continues to rise, the lag pump shall be energized. Upon a further increase in liquid level, the high water alarm light located on the face of the pump control panel shall be illuminated, an audible alarm shall be sounded, and the isolated alarm contact shall close. As the sump liquid level decreases to the "Pumps Off" setpoint, both pumps shall be de-energized. The pumps shall automatically

alternate lead-lag duty upon each cycle. Sump liquid level setpoints shall be as indicated in the Sump and Sewage Pump Schedule.

2-8.05. Heavy Duty Duplex Control System. Heavy duty duplex control systems shall consist of a control cabinet and sump level sensors for control of heavy duty duplex pumping systems.

2-8.05.01. Control Cabinet. The control cabinet shall include for each pump all controls specified herein or required for a properly operating system. The cabinet shall include the following features:

NEMA Type 4X metallic enclosure.

One main thermal magnetic circuit breaker disconnect with external lockable operating handle.

Two NEMA rated combination magnetic motor starters with motor circuit protector and manually reset bimetallic ambient compensated overload relays.

One pump alternator.

Two control power transformers with both primary leads fused and one secondary lead fused. One secondary lead shall be grounded.

Independent control power circuit for each pump. Control power circuits shall be interlocked such that one control power circuit serves as a backup to the other control power circuit.

Ground terminal, control relays, numbered and wired terminal strip.

Two 3 position “Test-Off-Automatic” selector switch for pump operation. Selector switch shall be spring return from Test to Off position. In “Test” position the pump shall run, in “Off” position the pump shall be off, in “Automatic” position the pumps shall run as specified in the control sequence paragraph.

One high water alarm “Test-Auto-Silence” switch when high water alarm is specified in the Sump and Sewage Pump Schedule. Switch shall be spring return from Test and Silence position to Auto position.

One high water audible alarm horn and silence pushbutton and alarm light when high water alarm is specified in the Sump and Sewage Pump Schedule. Alarm horn shall be 4 inch 95 dB and shall be mounted on the bottom of the cabinet. Alarm light shall be a red flashing light mounted on top of the cabinet.

Two red running lights, two white control power on lights, two red motor overload lights, two red motor high temperature alarm lights, two red moisture detected alarm lights.

Two elapsed time meters.

Two isolated dry type contacts for high water alarm, one common isolated dry type contact for motor overload, motor high temperature, moisture detected.

One alarm reset pushbutton. This button shall reset all alarm contacts. Alarm lights shall stay illuminated until the alarm condition is cleared.

2-8.05.02. Motor Protection. Each motor of heavy duty pumping units shall be protected by temperature switches mounted in each phase winding and designed to operate at 140°C ±5°C. The oil-filled seal chamber shall be provided with a moisture detection system furnished by the pump manufacturer, complete with all sensors, cables, control power transformers, auxiliary relays, and junction boxes. Motor protection controls shall be mounted inside the control cabinet. The temperature switches and moisture detection system shall be provided with a manual reset for explosionproof pumps and automatic reset for non-explosionproof pumps.

2-8.05.03. Liquid Level Sensors. Liquid level sensors consisting of an assembly of weighted ball floats with integral switches shall be furnished by the pump manufacturer. The sensors shall be suitable for duplex pump operation with high water alarm and shall be Weil "8230 Series". Each system of sensors shall be furnished complete with all required mounting brackets, weights, galvanized steel mounting pipes and accessories, control power transformers, auxiliary relays, cables, and junction boxes.

2-8.05.04. Control Sequence. Upon an increase in sump liquid level, the lead pump shall be energized. If the liquid level continues to rise, the lag pump shall be energized. Upon a further increase in liquid level, the high water alarm light located on the face of the pump control panel shall be illuminated, an audible alarm shall be sounded, and the isolated alarm contact shall close. As the sump liquid level decreases to the "Pumps Off" setpoint, both pumps shall be de-energized. The pumps shall automatically alternate lead-lag duty upon each cycle. Sump liquid level setpoints shall be as indicated in the Sump and Sewage Pump Schedule. In the event that moisture is detected in the seal chamber or if high motor temperature is detected, the respective alarm light located on the face of the control panel shall be illuminated and the pump shall be de-energized. The pump shall require a manual restart.

PART 3 - EXECUTION

3-1. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Pumping units shall be leveled, plumbed, aligned, and wedged into position to fit

connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards. Grouting shall be as specified in the Grouting section.

Special care shall be taken to ensure that piping stresses are not transmitted to the pump connections. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the pump connections. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

Control cables shall be supported to avoid tension and damage. Liquid level sensors shall operate freely and shall be adjusted to the levels indicated on the Drawings.

3-2. INSTALLATION CHECK. An installation check by an authorized representative of the manufacturer is not required.An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-3. STARTUP AND TESTING. Startup requirements and field performance testing shall be as indicated in the Startup Requirements section.

End of Section

Sump and Sewage Pump Schedule															
Unit Number	Location	Type	Capacity (GPM)	Total Head (FT)	Maximum Speed (RPM)	Motor HP	Power Supply Volts/Phase	Discharge Size (IN)	Sump Levels (FT)*				Manufacturer/ Model	Remarks	Permanent/ Portable
									OFF	LEAD	LAG	HWA			
SMP-R1	HEADHOUSE	Submersible, Heavy Duty Sewage Pump	42	25	1750	1	480/3	2	2	2.75	3.08	3.41	Weil 1607	1, 3, 4, 5	Permanent
SMP-R2	HEADHOUSE	Submersible, Heavy Duty Sewage Pump	42	25	1750	1	480/3	2	2	2.75	3.08	3.41	Weil 1607	1, 3, 4, 5	Permanent

*PUMPS OFF, LEAD PUMP START, LAG PUMP START AND HIGH WATER ELEVATIONS AS MEASURED FROM THE BOTTOM OF THE SUMP.

REMARKS:

1 – HIGH WATER ALARM
2 – EXPLOSION PROOF / DIVISION 1 / DIVISION 2 / (PUMPING UNIT ONLY)
3 – GUIDERAIL MOUNTED
4 – SUMP COVER REQUIRED
5 – LIFTING CHAIN REQUIRED
6 – CUTLESS RUBBER LOWER BEARING
7 – STUFFING BOX
*ADDITIONAL SUMP AND SEWAGE PUMPS ARE SHOWN ON PLUMBING DRAWINGS.

Section 11200

RECIRCULATING CHOPPER PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of single-stage, end suction centrifugal chopper type pumping units and controls as specified herein. The pump shall be specifically designed to pump and agitate waste solids at heavy consistencies. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through, mix and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications.

Pump Name	Pump Location	Equipment Tag
SRWRC Primary Clarifier Scum Pump No. 1	SRWRC Scum Well #1	PSC-PCL-10
SRWRC Primary Clarifier Scum Pump No. 2	SRWRC Scum Well #1	PSC-PCL-20
SRWRC Primary Clarifier Scum Pump No. 3	SRWRC Scum Well #2	PSC-PCL-30
SRWRC Primary Clarifier Scum Pump No. 4	SRWRC Scum Well #2	PSC-PCL-40

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Acceptable Products. Pumping unit shall be as manufactured by Vaughan, Hayward Gordon, Wemco or equal.

1-2.03. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.04 Reference Specifications and Standards

A. ANSI- American National Standard Institute

B. ASTM- American Society for Testing and Materials

C. HI- Hydraulic Institute

D. NEC- National Electric Code

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Shop Drawings, Product Data, and Samples section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps

Name of manufacturer.
Type and model.
Tag number.
Pump designation.
Rotative speed.
Size of discharge flange.
Net weight of pump and motor.
Complete performance curves showing capacity versus head, NPSH required, efficiency, and pump input power.
Data on shop painting.

Motors

Name of manufacturer.
Type and model.
Type of bearings and method of lubrication.
Rated size of motor, hp [kW], and service factor.
Insulation class and temperature rise.
Full load rotative speed.
Efficiency at full load and rated pump condition.
Full load current.
Locked rotor current.

Control Components

Type and manufacturer.
Model.
Enclosure rating.
Published descriptive data on all components, indicating all specific

characteristics and options.
Where liquid level sensors are provided, provide mounting details.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Operating and Maintenance Data section. Operation and maintenance manuals shall be submitted in accordance with the Operating and Maintenance Data section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-3.03. PERFORMANCE AFFIDAVIT AND EXPERIENCE. The Contractor shall submit manufacturer's standard warranty and a performance affidavit for equipment to be furnished in accordance with this section. The performance affidavit must include a statement that the equipment will not clog or bind on solids typically found in the application set forth. It is the express intent of these Specifications to accurately describe equipment that is a regular production item of the specified manufacturer, and that has a proven record of performance in identical (not just similar) applications in other treatment facilities. The chopper pump manufacturer shall have a minimum of twenty (20) years of documented experience in the design and production of chopper pumps of all types, and not less than ten (5) years of experience in the production of the exact equipment specified herein including but not limited to the automatic valve actuator recirculation system. Such experience shall be demonstrated to the Engineer by the provision of no less than twenty-five (25) reference installations of identical style chopper pumps in identical service applications. At least five (5) of the reference installations provided shall be of the exact model pump specified herein. References shall be pumps that have been used in continuous service for a period of no less than three (3) years. Only equipment that is in service at the time of referral shall be considered valid. Pumps that have been removed from service for any reason will not be considered as references. Telephone numbers and contact names shall be provided for any/all references upon request from the Engineer.

1-4. QUALITY ASSURANCE.

1-4.01. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine, shall not exceed vibration limits of the governing standard.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Transportation and Handling section. Storage shall be in accordance with the Storage and Protection section.

1-6. SPARE PARTS. The following spare parts and accessories shall be furnished in substantial wooden boxes with identifying labels and delivered to the OWNER.

Spare Parts	Quantity
Set of mechanical seals	One per pump
Casing wearing rings	One per pump
Impeller wearing rings	One per pump
Sets of bearings	One per pump
Sets of bearing seals	One per pump

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The vertical recirculating chopper pump will be used for pumping scum from the primary clarifiers to the existing digesters. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The pumps must have demonstrated the ability to grind through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products, and stringy materials without plugging, both in tests and field applications. Pumps installed in a hazardous location and shall be rated for use in Class 1 Division 2 area.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Pumping units shall be designed for continuous service under the following operating conditions and requirements at rate speed unless otherwise noted:

Vertical Pumps

Pump tag numbers	PCL-10, PCL-20, PCL-30, PCL-40	
Ambient Temperature Range	55°-85°	F
Ambient Relative Humidity Range		%
Fluid Temperature Range	55°-85°	F
Fluid pH Range	4.0 to 8.0	

Fluid Specific Gravity	1.01 to 1.05	
Project Site Elevation	805 ft	ft
Rated head	48	ft
Capacity at rated head	150	gpm
Min shutoff head	20	Ft
Operating head range for full speed continuous operation	40-50	Ft
Maximum nominal pump speed	1750	Rpm
Maximum power required at pump input shaft at any point from minimum operating head to shutoff head	7.5	bhp
Maximum Motor Size	10	Hp
Motor Voltage Requirements	480V, 3 Ph, 60 Hz, AC	
Maximum Motor Speed	1800	rpm
Motor Drive Type	Direct drive with C-flanged motor and elastomeric coupling. Constant speed. Coupling guards per OSHA are required	
Wetwell depth	17	ft
Minimum liquid depth in wetwell	2	ft
Minimum NPSHA at rated head	5	ft
Minimum pump discharge nozzle/elbow size	3	In

Minimum hydrostatic test pressure shall be 1.5 times the shutoff head.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences.

2-3. MATERIALS.

Casing	Ductile iron, ASTM A536.
Impeller	Alloy steel, ASTM A148, case hardened to Rockwell C60.
Main cutter bar	Ductile iron, ASTM A536, case hardened to Rockwell C60.
Shaft	AISI Type 410.
Pump shaft bearings	Oil-bathed lubricated by I.O.S. Grade 46 turbine oil, with the exception of the top bearings, which shall be grease packed.
Mechanical Seals	316 SS.

2-4. PUMP CONSTRUCTION.

2-4.01. Casing Assembly. Shall be of semi-concentric design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150 lb flanged discharge. Casing shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics.

2-4.02. Impeller. Shall be semi-open chopper type. Chopping/maceration of materials must be accomplished by the action of the curved, cupped and sharpened leading edges at the bottom of the impeller blades as they move across the cutter bar, creating a smooth efficient slicing effect. Pump out vanes must be provided across the entire diameter of the impeller on the backing plate, in order to reduce pressure in the seal area, and to draw lubricant down from the reservoir should seal leakage occur. The impeller shall be held in place with a key, shall have no axial adjustments or set screws, and shall not extend past the cutter bar. The impeller shall be cast steel heat treated to a minimum 60 Rockwell C Hardness, and dynamically balanced.

2-4.03. Cutter Bars. Shall be a single cast component recessed into the pump bowl, with a funnel shaped inlet opening. As a part of the casting, segment bars shall extend inwardly, to within .015 inch of the cutter nut. The set clearance between the cutter bar and impeller shall be adjustable to .005 inch to .020 inch. The cutter bar shall be cast steel heat treated to a minimum 60 Rockwell C Hardness. The design running clearance between the impeller and the cutter bar shall be not less than 0.01.

2-4.04. Upper Cutter Assembly. The impeller pump-out vanes shall be specially modified to shear against an upper cutter assembly mounted into the back side of the casing, in order to eliminate any build up of rags, hair, or other stringy material in the seal area or between the impeller and the pump casing. The upper cutter shall consist of no more than 2 cutting anvils to minimize the potential for binding. The set clearance between the impeller and upper cutter shall be adjustable to .010 inch or less. The upper cutter shall be cast steel heat treated to a minimum 60 Rockwell C Hardness.

2-4.05. Cutter Nut. The cutter nut shall be used to affix the impeller to the shaft, and to eliminate binding or wrapping of stringy materials at the pump inlet. The cutter nut shall consist of a hex head sufficiently sized for ease of removal, and shall include an integral cast anvil which shears against the adjacent surface of the segment bars on the cutter bar. The cutter nut shall be cast steel heat treated to a minimum 60 Rockwell C Hardness.

2-4.06. Recirculation Nozzle for submersible type pumps. The submersible type pump shall be fitted with a recirculation nozzle assembly to permit recirculation of the pit contents prior to discharge. The recirculation nozzle shall be adjustable minimum 180 degrees horizontally and 45 degrees vertically.

2-4.07. Valve. Shall be connected to the submersible pump discharge to adjust pump flow either to the recirculation/mixing nozzle or the pump discharge flange. Valve shall be ductile cast iron with 316 stainless steel valve disk.

2-4.08. Operating Levers . Shall be located above the access hatch for easy access during pump operation.

2-4.09. Pump Shafting. The pump shaft and impeller shall be supported by ball bearings. There shall be a heat treated stub shaft through the pump casing connected through a solid steel shaft coupling to a stress-proof shaft extension to the top of the pump. All shafting shall have a minimum diameter of 1.5 inches in order to minimize deflection during solids chopping.

2-4.10. Pump Support Column. The shaft column shall be 4 inch OD precision steel tubing welded to steel flanges and machined with piloted bearing fits for concentricity of all components. All support columns tubes shall be leak tested. Distance between shaft bearings shall not exceed critical speed dimensions.

2-4.11. Pump Shaft Ball Bearings. Lower and intermediate bearings shall be oil bath lubricated by I.S.O. Grade 46 turbine oil. The top bearings shall be permanently greased packed. Bearings shall have a minimum B-10 life rated 100,000 hours.

2-4.12. Thrust Bearings . Shaft thrust shall be taken up by either a double row angular contact ball bearing or two back-to-back mounted single row angular contact ball bearings, which bear against a machined shoulder on one side and the seal sleeve on

the other side. Overhang from the centerline of the lower thrust bearing to the seal faces shall be a maximum of 1.2 inches. Shaft overhang exceeding 1.2 inches from center of lower thrust bearing to seal faces shall be considered unacceptable. A mechanical seal shall isolate the bearings from the pumped media at operating temperatures to 250o F.

2-4.13. Mechanical Seal. Shall be 316 stainless steel cartridge type and fitted with silicon carbide seal faces to provide long life expectancy in the presence of grit and abrasive solids. The seal shall include a 316 stainless steel shaft sleeve, with the seal tension held integral to the cartridge assembly. Seal shall be tested for flatness within 2 helium light bands under a helium light source and optical flat. All elastomers shall be Viton®. Remaining pump elastomers shall be BunaN.

2-4.14. Automatic Oil Level Monitor. Shall be located above the mounting plate and be fitted with an internal 50 watt capacity oil level switch to detect oil level and shut off the motor in event of low oil level. A sensitive relay shall be included for mounting in each control panel.

2-5.15. Pump Discharge Pipe. The pump assembly shall be mounted vertically on a common steel base plate with 150 pound standard discharge flange. The pump shall be fitted with a below deck discharge flange as shown in the Drawings.

2-5.16. Motor Support Base. Shall be a fabricated carbon steel weldment machined with piloted fits to positively align the C-flange motor and pump shaft, with no adjustments required.

2-5.17. Shaft Coupling. The shaft coupling shall be T. B. Woods “Sureflex” elastomeric type or equal, with a minimum 1.5 service factor based on the drive rated horsepower and shall be protected with a guard meeting OSHA requirements.

2-5.18. Pump Base Plate. The pump base plate shall be fabricated carbon steel, 1/2-inch minimum thickness, and shall include lifting lugs.

2-5.19. Stainless Steel Nameplates. Nameplates shall be stainless steel and be attached to the pumps and drive motors. Nameplates shall contain the manufacturer's pertinent data.

2-5. ELECTRIC MOTORS.

Motors shall be as specified in Section 16220, General Purpose Induction Motors. The motor shall be sized for non-overloading conditions. The motor shall be rated for installation in hazardous area.

The motor shall be furnished with a motor space heater rated 120 volts ac. The motor space heater shall be sized to prevent condensation on motor windings.

2-6. CONTROLS.

2-6.01. Liquid Level Sensors. Sensors consisting of an assembly of weighted ball floats with integral switches per requirements of section 17563 shall be furnished by the pump manufacturer. The sensors shall be suitable for duplex pump operation with three sensors for low pit level (pump stop), pit high level (pump start) and high-high pit level (high level alarm). The system of sensors shall be furnished complete with all required mounting brackets, weights, stainless steel mounting pipes and accessories, control power transformers, auxiliary relays, cables, and junction boxes.

2-6.02. Pump Controls. Control equipment for each pair of pumps shall include a control panel to be located on the top of the scum well as shown on plans and per applicable requirements of sections 16050, 17500, 17561, 17563, and 17570. One control panel shall be provided per scum well. Control panel shall be NEMA 4X stainless steel rated and shall be UL 508A listed per requirements of 17570. The short circuit current rating shall be 14,000 amps minimum or as required from short circuit coordination study.

The panel shall be provided with a circuit breaker disconnect, thermal-magnetic motor starters (NEMA Size 1, minimum), control relays, pilot devices, a 480/120 volt control power transformer, a "Local-Off-Remote" maintained selector switch, an amber “motor overload” indicating light, a red “running” indicating light, an amber “run pending” indicating light, an amber “run request” indicating light, alarm relays, interposing relays and other controls required for a complete and functional system. The pilot lights shall be push-to-test type. The control equipment shall be provided with a set of form “C” dry contacts (normally open and normally closed) to facilitate connection to a Plant Control System (PCS) rated 5 amperes at 120 volts. The contacts shall be normally open or normally closed and shall change state upon any alarm condition.

Control panel shall include intrinsically safe relays for each liquid level sensor in accordance with NEC requirements and shall be Gems "Safe-Pak", B/W "Series 53", or equal.

Scum pit pumps shall be controlled by the plant control system as indicated on the Drawings and specified herein.

Normally open contact inputs and outputs to be monitored and controlled by the plant control system shall be provided with the control equipment as follows:

Pump Running Status (contact closes when the pump is running)

Pump Fail Alarm Status (contact closes on motor overload)

Pump High Motor Temperature Alarm Status

Low Low Scum Pit Level Indication

High Scum Pit Level Indication

High High Scum Pit Level Level

Pump Local – Off – Remote Switch 'In Remote' Control Mode Indication

Scum Pump Remote 'Call To Run' Control Command

The pump fail contact shall remain closed until reset at the control equipment.

2-6.03. Control Modes.

2-6.03.01. Local Mode. When the selector switch is placed in the "Local" position, the pump shall run. When the pit low level is reached, the pump shall be de-energized until an increase in pit level.

2-6.03.02. Remote Mode. When the selector switch is placed in the "Remote" position, upon an increase in pit liquid level to the high level setpoint, the 'Lead' pump shall be energized. Upon a further increase in liquid level, the High High Water Alarm Light located on the face of the pump control panel shall illuminate, and the 'Lag' Pump shall start (if available). As the scum pit liquid level decreases to the low pit level setpoint, all running pump(s) shall be de-energized. The scum pumps shall alternate Lead / Lag selection when two (2) pumps are available after Low Scum Pit level is reached.

2-7. SHOP TESTS. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall conform to the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be Level A, with no minus tolerance or margin allowed.

Five certified copies of a report covering each test shall be prepared by the pump manufacturer and delivered to Engineer not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, bhp [brake kW], pump efficiency, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements. All test points shall be clearly shown.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation will be in accordance with the Equipment Installation section and as recommended by the pump manufacturer.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

The services of the manufacturer’s representative shall be provided for a period of not less than two days, one to supervise the initial installation and one to supervise start up and instruct the Owner’s personnel in proper operation and maintenance of the equipment.

All costs for the manufacturer’s services shall be included in the allowance price for the number of days and round trips to the site as required.

3-2. 02 PAINTING. Each pumping unit shall be factory-prepared, primed, and finish-coated with the manufacturer's standard protective coating system, provided it meets or exceeds the requirements of Section 09940, Protective Coatings.

End of Section

SECTION 11295

COMPOSITE GATES

PART 1 - GENERAL

1-1. DESCRIPTION.

1-1.01. Scope. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install composite slide gates and weir gates and appurtenances complete and operational.

Included are composite slide gates and weir gates, anchorage systems and all appurtenances.

Extent of the equipment is shown on the Composite Gate Schedule located at the end of this Section.

1-1.02. Coordination. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the composite gates Work.

1-2. REFERENCES

1-2.01. Standards referenced in this Section are listed below:

1. American Society for Testing and Materials, (ASTM).
   a. ASTM A 276, Specification for Stainless Steel Bars and Shapes.
   b. ASTM B 584, Specification for Copper Alloy Sand Castings for General Applications
2. National Electrical Code, (NEC).
3. National Electrical Manufacturers' Association, (NEMA).
4. AWWA C563-12

1-3. QUALITY ASSURANCE

1-3.01. Manufacturer’s Qualifications:

1. Manufacturer shall have a minimum of five years of experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

2. Composite gates shall be the product of one manufacturer.

1-3.02. Component Supply and Compatibility.

Obtain all equipment included in this Section regardless of the component manufacturer from a single composite gate manufacturer.

The composite gate equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.

All components shall be specifically designed for the specified service and shall be integrated into the overall assembly by the composite gate equipment manufacturer.

1-3.03. Performance Requirements. Composite gates shall be designed for the seating and unseating heads as listed in the gate schedule. Gates shall conform to the AWWA C563-12. Conformance to AWWA C563-12 applies to discs and frames with a safety factor of five (5) with regard to tensile, compressive and shear strength and with the requirement that all gates will yield no more leakage than shown in the standard for Field Leakage Test. Calculations shall be submitted to show conformance. Materials of construction shall be suitable for the environment in which the sluice gates shall be installed and operated.

1-4. SUBMITTALS

1-4.01. Action Submittals: Submit the following:

Shop Drawings:

a. Fabrication, assembly and installation diagrams.
b. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
c. Wiring diagrams for electric motor operators.

Product Data:

d. Manufacturer's literature, illustrations, specifications and engineering data.
e. Deviations from the Contract Documents.
f. Lubricant Specification: Furnish a lubricant specification for the type and grade necessary to meet the requirements of the equipment.

1-4.02. Informational Submittals: Submit the following:

Support Design Information: Submit for record purposes only the weight of each slide gate and expected opening and closing thrust loads on the supporting structure.

Shop Test Results: Submit results of required shop tests.

Field Test Results: Submit a written report giving the results of the field tests required.

1-4.03. Closeout Submittals:
Operation and Maintenance Manuals: Submit complete Installation, Operation and Maintenance Manuals including, test reports, maintenance data and schedules, description of operation and spare parts information.

Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1-5. DELIVERY, STORAGE AND HANDLING.

1-5.01. Packing, Shipping, Handling and Unloading: Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work

.

Handle all composite gates and appurtenances properly, in accordance with manufacturer's recommendations. Composite gates, which are distorted or otherwise damaged, will not be acceptable. Protect all bolt threads and ends from damage.

1-5.02. Storage and Protection: Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

Store all mechanical equipment in covered storage off the ground and prevent condensation.

1-5.03. Acceptance at Site: All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1-6. WARRANTY:

1-6.01. The Manufacturer shall warrant the gates, when installed and operated as recommended by the Manufacturer with a documented maintenance program, trouble-free operation for a period of two (2) years from the date of Substantial Completion. If the Owner or Engineer is not completely satisfied with the performance of the product, the Manufacturer shall remedy the problem at no cost or refund the materials and installation cost upon the return of the equipment.

1-6.02. Leakage shall be no more than that allowed by the AWWA C563-12 Standard during the warranty period.

1-6.03. Door (disc) shall be free of sticking or binding as judged by the Engineer (move freely via operator provided) with no exercising required. Gate operators are to be warranted by the operator manufacturer.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS

2-1.01. General: Design composite gates to safely withstand conditions listed in Composite Gate Schedule, located at the end of the Section.

Composite gates shall be substantially watertight with leakage less than allowable by AWWA C563-12 at design head.

Manual operators shall turn right to close, unless otherwise specified. Operators shall indicate the direction of operation.

Bolts, studs, cap screws, and adjusting screws shall be of ample section to withstand the force created by operation of the gate under a full head of water.

Downward opening composite weir gates shall be capable of being lowered to an elevation below the invert of the channel or opening.

Composite gates shall open to not less than 6-inches above the maximum water level in the channel in which they are installed.

2-2. MANUFACTURERS

2-2.01. Provide equipment of one of the following:

1. Ashbrook-Simon-Hartley COPLASTIX LINE
2. Or Equal.

2-3. FABRICATION

2-3.01. Materials of Construction: Stainless Steel: For frame, yoke and rails ASTM A 276, Type 316 stainless steel. All metal for composite gate parts shall have a minimum thickness of 3/8-inch.

Bronze Casting: For operating nut, thrust nut and lift nut, ASTM B 584 Alloy 865.

All bolts, studs, cap screws and adjusting screws shall be of Type 316 stainless steel.

Bolts and nuts shall have hexagon heads.

Installation shall conform to manufacturer's recommendations based upon the use of a suitable non-shrink grout; mounting gates to a concrete wall using flexible gasket will not be acceptable.

All fixing angles shall be full and continuous, no tab fixing is acceptable.

2-3.02. Gate Body: Shall be constructed from a reinforced rigid composite plastic material, having a minimum thickness of 1/8-inch. Gate body shall have an internal matrix of carbon steel of suitable strength for the specified service. The outer surface skins shall be a homogeneous composite material having extremely high tensile and

impact strength, be nontoxic and shall be stabilized against ultraviolet light. The plastic material shall be an Aramid fiber from the KEVLAR family of fibers, and shall have the following minimum properties and shall be designed to limit the deflection to a maximum of 1/1000 of the span under design head conditions based upon horizontal support members only. Manufacturer shall submit drawings and comprehensive design criteria to substantiate that the required deflection figure for each door has been achieved. Comprehensive safety factor calculations shall include bending moments, buckling stress, and bonding stress with thermal expansion factors suitable for reference in NASA CR-1457, "Manual for Plates and Shells". et al. Safety factors shall be calculated for the gate under maximum head, and shear at the disc/seal interface.

2-3.03. Seals: The sealing arrangement for the reinforced composite gates shall comprise of sealing faces and side guides constructed of ultra-high molecular weight polyolefin having an extremely low coefficient of friction and a backing constructed of highly resilient expanded neoprene. Guides and seating of the gate shall be easily adjustable (min. 5/8-inch). All moving contact surfaces shall be compatible to each other thereby minimizing sticking / jamming and making the operation easy. Any seal that needs replacement in less than 10 years shall not be acceptable.

2-3.04. Fasteners: Shall be 316 stainless steel. All anchor bolts, assembly bolts, screws, nuts, etc. shall be of ample section to safely withstand the forces created by operation of the gate while subjected to the heads specified.

2-3.06. Stem: Operating stems shall be of Type 316 stainless steel and designed as specified below.

Design stem to transmit in compression at least 2-1/2 times the rated output of the operating mechanism with an 80-pound effort on the crank or hand wheel. Determine the critical buckling load using the Euler column formula, using C = 2. Where hydraulic cylinder lifts are used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic cylinder with a pressure equal to the maximum working pressure of the hydraulic fluid supply. Where electric motor driven lifts are used, the stem design force shall not be less than 1.25 times the output thrust of the unit in the stalled motor condition.

Stems shall have a slenderness ratio (L/R) less than 200.

Threaded portion of the stem shall have machined cut threads of the Acme type. Join stems of more than one section by stainless steel couplings threaded and keyed or threaded and bolted. All threaded and keyed couplings of the same size shall be interchangeable. Couplings shall be designed to be of greater strength than the stems.

Connect the stem to the disc by means of a threaded and keyed connection.

Provide rising stems with an adjustable stop collar on the stem above the floor stand lift nut.

2-4. APPURTENANCES

2-4.01. Stem Guides: Stem guides shall be fabricated from Type 316 stainless steel and shall be equipped with UHMW polyethylene or UHMW polymer bushing.

Guides shall be adjustable in two directions and shall be spaced in accordance with AWWA C563-12.

Anchor bolts for stem guides shall be Type 316 stainless steel.

2-4.02. Anchor Bolts: Provide Type 316 stainless steel anchor bolts as required for stem guides, floor stands, and all equipment or appurtenances, which must be secured to concrete walls or floors. Anchor bolts shall be of ample size and strength for the purpose intended, and shall be furnished by the manufacturer. Provide heavy duty epoxy anchoring system suitable for anchoring in existing concrete structures.

2-4.03. Stem Cover: Furnish all stems with a clear polycarbonate or butyrate plastic pipe stem cover. Covers shall be furnished with a cast aluminum adaptor for mounting covers to floor stands. Stem covers shall be designed and furnished with a gasket and breathers to eliminate water intrusion into operators and condensation within the covers.

The stem cover shall be equipped with a clear mylar position indicating tape. The tape shall be field applied on the stem cover after the gate has been installed and positioned. As a minimum, the tape shall indicate the gate position at 1/4 open, 1/2 open, 3/4 open and fully open.

2-4.04. Identification: Identify each composite gate with a stainless steel nameplate stamped with the approved designation as shown in the Composite Gate Schedule, located at the end of this Section. Nameplate shall be permanently fastened to the gate at the factory.

2-5. SURFACE PREPARATION AND PAINTING.

2-5.01. Clean, prime coat, and finish coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 09940, Protective Coatings.

2-5.02. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound, which shall be maintained during storage, and until equipment begins operation.

2-5.03. Contractor shall certify, in writing, that the shop primer and coating system conforms to the requirements of Section 09 9905, Protective Coatings.

2-6. SOURCE QUALITY CONTROL.

2-6.01. Shop Tests: Test each composite gate fully assembled for proper seating. Fully open and close gate disc in its guide system to ensure that it operates freely.

Operate and test floor stands, bench stands and motor operators to ensure proper assembly and operation.

If gates, operators, and appurtenances do not meet specified requirements, corrective measures shall be taken by the Contractor, or the equipment shall be removed and replaced with equipment that satisfies the conditions specified.

2-7. COMPOSITE GATE SCHEDULE.

2-7.01. The Composite Gate Schedule is located at the end of this Section. Conform to type, size, operation and other data specified, unless otherwise approved by Engineer.

2-7.02. Schedule Abbreviation:

Type:

a. EF - Embedded Frame.
b. SM - Surface Mounted Frame.
c. WG - Downward Opening Weir Gate.
d. SG – Slide Gate.

Operator Type:

e. CO - Crank Operated.
f. HW – Hand wheel.
g. MO - Motor Operated.

2-7.03. The seating and unseating design head as stated in the Composite Gate Schedule is based on the head measured to the centerline of the gate in its closed position.

PART 3 - EXECUTION

3-1. INSTALLATION.

3-1.01. Install composite gate equipment in accordance with manufacturer's instructions and recommendations.

3-1.02. Set anchor bolts in accordance with approved Shop Drawings and manufacturer's recommendations.

3-1.03. Adjust all parts and components as required to provide correct operation.

3-2. START-UP AND FIELD TESTS.

3-2.01. After Contractor and Engineer have mutually agreed that the equipment installation is complete and ready for continuous operation, Contractor and a qualified field service representative of the manufacturer shall conduct a functional field test and a leakage test of each composite gate in the presence of Engineer to demonstrate that

each composite gate furnished will function correctly and that maximum permissible leakage is not exceeded.

Functional Tests: Each composite gate with appurtenances shall be field-tested. Tests shall demonstrate to Engineer that each part and all parts together function in the manner intended. All necessary testing equipment and manpower shall be provided by Contractor at their expense. City will furnish all power, and incidental material and labor required for the tests.

Leakage Tests: Maximum permissible leakage shall be in accordance with the requirements of Paragraph 2.1, above. Excess leakage shall be reduced to meet specified requirements by adjusting the gate, or replacement will be required.

In the event that the manufacturer is unable to demonstrate to Engineer that their equipment meets the requirements of the tests, the deficient equipment will be rejected and Contractor shall adjust and/or modify and retest the equipment as often as necessary to meet the specified requirements. No separate payments shall be made for adjustments and/or modifications.

3-3. MANUFACTURER'S SERVICES.

3-3.01. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 8 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the Engineer and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

3-3.02. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the City.

End of Section

Electric Actuated Gate Schedule

Size	Service	System Code	Function Code	Number	PID DRAWING	Gate Type	Mech Drawings	Location	Type of Closure	Wall Thimble	Invert	Design Head-seated	Design Head-unseated	Operating Floor elevation
144"x48"	SO	PRC	GSD	10	IB001	Electric Actuated Weir Gate - Self Contained	MD101	Clarifier Influent Junction Box	CC	-	796.3	4	4	806.68
144"x48"	SO	PRC	GSD	20	IB001	Electric Actuated Weir Gate - Self Contained	MD101	Clarifier Influent Junction Box	CC	-	796.3	4	4	806.68
144"x48"	SO	PRC	GSD	30	IB001	Electric Actuated Weir Gate - Self Contained	MD101	Clarifier Influent Junction Box	CC	-	796.3	4	4	806.68
144"x48"	SO	PRC	GSD	40	IB001	Electric Actuated Weir Gate - Self Contained	MD101	Clarifier Influent Junction Box	CC	-	796.3	4	4	806.68

Notes:
1) Abbreviations for services are as indicated:
- SO - Shutoff, Gate will normally be fully opened or closed
- THT - Throttling

2) Abbreviations for Wall Thimbles are as indicated:
- ER - "E" Shape, Rectangular
- EC - "E" Shape, Circular
- ECSP - "E" Shape, Circular, for Connection to steel pipe
- FR - "F" shape, Rectangular
- FC - "F" Shape, Circular
- FMJ - Flange and Mechanical Joint
- PF - Attach gate frame to pipe flange; wall thimble not required

3) Abbreviations for types of closures are as indicated:
- CC - Conventional Closure
- FB - Flush Bottom Closure

Hand Actuated Gate Schedule

Size	Service	System Code	Function Code	Number	PID DRAWING	Gate Type	Mech Drawing	Location	Type of Closure	Wall Thimble	Invert	Design Head-seated	Design Head-unseated	Operating Floor elevation
36"x36"	SO	SCR	SLD	10	IB005	Hand Actuated Gate	MD103	Influent Diversion Box	CC	FMJ	777	29	8	810.5
48"x48"	SO	SCR	SLD	20	IB005	Hand Actuated Gate	MD103	Influent Diversion Box	CC	FMJ	777.5	28.5	8	810.5

Notes:

1) Abbreviations for services are as indicated:
   - SO - Shutoff, Gate will normally be fully opened or closed
   - THT - Throttling
2) Abbreviations for Wall Thimbles are as indicated:
   - ER - "E" Shape, Rectangular
   - EC - "E" Shape, Circular
   - ECSP - "E" Shape, Circular, for Connection to steel pipe
   - FR - "F" shape, Rectangular
   - FC - "F" Shape, Circular
   - FMJ - Flange and Mechanical Joint
   - PF - Attach gate frame to pipe flange; wall thimble not required
3) Abbreviations for types of closures are as indicated:
   - CC - Conventional Closure
   - FB - Flush Bottom Closure

Section 11309

SUBMERSIBLE NON-CLOG CENTRIFUGAL PUMPS

PART 1 – GENERAL

1-1. SUMMARY

1-1.01. This Section includes requirements for providing submersible non-clog centrifugal pumps and all accessories and appurtenances as specified and shown on the Contract Drawings.

Unless indicated on the drawings, all equipment shall be suitable for use in a Class 1, Division 1 environment.

Each pumping unit shall be complete with close-coupled, submersible electric motor, adjustable frequency drive and all other appurtenances specified, or otherwise required for proper operation.

1-2. QUALITY ASSURANCE

1-2.01. All equipment in this Section shall be furnished by or through a single supplier. The contractor shall be responsible for the design, coordination and proper operation of the entire system. Pumps shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

1-2.02. The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

1-3. DEFINATIONS/STANDARDS

1. Anti-Friction Bearing Manufacturers Association (AFBMA).
2. American Gear Manufacturers Association (AGMA).
3. American National Standards Institute (ANSI).
4. American Society of Mechanical Engineers (ASME).
5. American Society for Testing and Materials (ASTM).
6. National Electrical Manufacturers Association (NEMA).
7. Occupational Safety and Health Administration, Code of Federal Regulations (OSHA).

1-4. EQUIPMENT IDENTIFICATION

1-4.01. Equipment covered under this specification is identified as follows:

Equipment Name	Equipment Tag
Transfer Pump No.1	PCL-10
Transfer Pump No.2	PCL-20
Transfer Pump No.3	PCL-30
Transfer Pump No.4	PCL-40
Transfer Pump No.5	PCL-50
Transfer Pump No.6	PCL-60

1-4.02. SUBMITTALS. Submittals shall conform to the General Conditions.

1-4.03. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

In addition to those submittals identified in the General Conditions, the following items shall also be submitted:

Performance data curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the design point.

Catalog data on pumps, motors, and all appurtenances.

Certified pump curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point. Pump curves shall be shown in 100 RPM increments or increments of frequency (Hz) over the entire operating range.

Installation or placing drawings for equipment, drives and bases.

Suggested spare parts list with current price information.

List of special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)

List of materials and supplies furnished with the equipment.

Requirements for storage and protection prior to installation.

Requirements for routine maintenance required prior to plant startup.

Motor submittals including motor and motor protection relay manufacturer's catalog information, motor drawings with motor nameplate data and efficiency, speed range, and maximum starts per hour. Wiring diagrams shall show power and control wiring terminal connections.

Manufacturer's installation recommendations and instructions for the submersible, non-clog centrifugal pumps.

Submit Operation and Maintenance Manuals in accordance with General and Special Conditions.

Submit Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of this Specification.

1-4.04. DELIVERY, STORAGE AND HANDLING. After testing and before dismantling pumping equipment for shipment, all wiring and mechanical connections shall be match-marked or tagged to ensure proper field assembly.

Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, and type or grade. Complete packing lists and bills for material shall be included with each shipment. Each item of equipment shall be tagged or marked with the same identification number or mark as shown on the packing lists and bills of material.

Protect materials and equipment from exposure to the elements and keep dry at all times. Handle and store to prevent damage and in accordance with manufacturer's recommendations.

Materials and equipment damaged by handling and storage shall be repaired or replaced by the Contractor.

Pumps shall be protected against corrosion during storage and prior to being placed in operation. Machined surfaces shall be flushed with heavy, noncorrosive oil, and bearing shall be lubricated. Contractor shall inspect the stored pump weekly, shall manually rotate or slide all moving parts, and shall renew the lubrication as necessary. Before the pump is put into operation, it shall be cleaned.

Ship the pump motor protection relays to the Variable Frequency Controller

manufacturer for installation in the Variable Frequency Controller Enclosure.

PART 2 - PRODUCTS

2-1. MANUFACTURERS AND SYSTEM SUPPLIERS

If any other manufacturer other than those listed in this Section is proposed by the Contractor for the Work covered in this Section, it shall be the responsibility of the Contractor to perform any required redesign and coordination associated with, but not limited to, mechanical equipment layout, electrical wiring, conduit and controls, and structural/architectural work, at no additional cost to the Contract.

No substitution of the listed manufacturer(s) will be allowed without prior approval by the Engineer, in accordance with the requirements outlined on the Bid Form.

2-1.01. Acceptable Manufacturers

1. Flygt
2. Or Approved Equal

2-2. GENERAL

2-2.01. Pumps. Pumps shall be of the wet-pit, submersible, solids handling, non-clog centrifugal type. Pumps shall be capable of pumping raw, unscreened wastewater, and shall be capable of passing diameter spherical solids as listed in the section entitled “Performance Requirements” below.

Pumps shall be specifically designed for continuous duty operation in a submerged pump application. The pumps shall not overload the motors at any point on the pump performance curve within the operating limits recommended by the pump manufacturer.

The pump, with its appurtenances and cable, shall be capable of continuous submergence without loss of watertight integrity to a depth of 50 feet.

2-3. PERFORMANCE REQUIREMENTS

2-3.01. South River Transfer Pumps Performance

1. No. of pumps	6
2. Pump configuration	Non-Clog Submersible, centrifugal
3. Minimum Shutoff Head	235 ft.
4. Design Point @ rated speed	6,481 gpm @ 141 ft. TDH
5. Design Point wire to	

	water efficiency:	76%
6.	Maximum Flow @ Rated Speed:	6,720 gpm @ 145 ft. TDH
7.	Maximum Flow wire to water efficiency:	76%
8.	Minimum Flow	4,861 gpm @78 ft. TDH
9.	Minimum Flow wire to water efficiency:	73%
10.	Pump Rated Speed:	1190 rpm
11.	Min. Pump Discharge Diameter:	16”
12.	Type of impeller	Radial Non-clog
13.	Liquid pumped	Wastewater
14.	Suction conditions	Flooded
15.	Minimum sphere passage	4.5 inches
16.	Motor Horsepower:	500 Hp Maximum
17.	Drive Type:	Variable Frequency

2-3.02. Motor

1.	Motor Type:	Submersible, Squirrel Cage Induction Type
2.	Nominal Motor Speed:	Coordinate with Pump RPM Requirements
3.	Motor Efficiency:	Premium Efficient
4.	Design:	NEMA Design B
5.	Duty:	Continuous, Ten starts per hour (minimum)
6.	Insulation:	Class H, Inverter Duty Rated per NEMA MG-1, part 31
7.	Voltage:	460V, 3 Ph., 60 Hz.
8.	Service Factor:	1.15 (The motor service factor shall not be used in sizing the motors)
9.	Motor Enclosure:	Submersible, housed in an air-filled, watertight chamber. Cast Iron Construction Suitable for use in Class 1, Division 1 locations.
10.	Protection:	Integral Motor Winding Thermostats & Seal Fail Sensors

2-4. MATERIALS AND CONSTRUCTION

2-4.01. Where watertight sealing is required, O-rings made of Viton shall be used. All mating surfaces where water tight sealing is required shall be such that sealing is accomplished by metal to metal contact between machined surfaces, resulting in a controlled compression of Viton O-rings without the requirement of a specific torque limit

to affect the seal. No rectangular gaskets, elliptical "O"-rings, grease, or other devices shall be used.

2-4.02. Design pumps to allow for removal and reinstallation without the need to enter the wet well and without removal of bolts, nuts or other fasteners.

2-4.03. Provide a pump which connects to a permanently mounted discharge connection by simple downward motion, without rotation, guided by at least two schedule 40, Type 304 stainless steel guide bars extending from the top of the station to the discharge connection. Final connection shall insure zero leakage between pump and discharge connection flange and shall be accomplished be a machined metal to metal watertight contact.

2-4.04. Provide a discharge connection/guide system so that no part of the pump bears directly on the floor of the wet well.

2-4.05. Furnish major components (pump case, impeller, intermediate housing, motor housing) of cast material as specified with smooth surfaces devoid of blow holes and other irregularities.

2-4.06. All major castings shall be produced in the pump manufacturer's own foundry, under the manufacturer's direct supervision.

2-4.07. All exposed nuts and bolts shall be of AISI Type 316 stainless steel construction. All surfaces coming into contact with sewage, other than stainless steel or bronze, shall be protected by an approved sewage resistant coating.

2-4.08. Impeller and wear rings Provide non-clog type impeller, capable of passing at minimum diameter spherical solid as indicated in the “Performance Requirements” section above.

Statically and dynamically balance the impeller.

Provide hard metal wear rings on case of material and Brinell hardness so as to ensure maximum pump/impeller life and continuing high efficiencies.

The use of soft metals (i.e. bronze, 304 or 316 stainless) or elastomers as wear ring material is incompatible with the grit contaminate expected in the pumpage and will therefore be strictly prohibited.

2-4.09. Shaft. Provide common pump/motor shaft of sufficient size to transmit full driver output with a maximum deflection of 0.002 inches measured at the lower mechanical seal.

The pump shaft shall be AISI type 420 stainless steel.

The use of carbon steel as shaft material shall be strictly prohibited.

2-4.10. Shaft Seal. Provide two totally independent mechanical shaft seals, installed in tandem, each with its own independent spring system acting in a common direction.

Install the upper seal in an oil-filled chamber with drain and inspection plug (with positive anti-leak seal) for easy access from external to the pump.

Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.

Provide seals, which are non-proprietary in design, with replacements available from a source other than the pump manufacturer.

Do not provide seals with the following characteristics: Conventional double mechanical seals with single or multiple springs acting in opposed direction; cartridge-type mechanical seals; seals with face materials other than those specified; seals using the impeller hub as a mounting surface.

2-4.11. Bearings. Furnish upper and lower bearings to provide a L10 life of, at minimum, 100,000 hours at maximum axial and radial loadings.

Provide either sealed/shielded (permanently lubricated) or open (regreasable) bearings.

If open-type (non-shielded) bearings are used, provide re-lubrication ports with positive anti-leak plugs for periodic addition of lubrication from external to the pump.

2-4.12. Motor. Motors shall be capable of supplying the maximum rated horsepower and rpm at the conditions and within the ranges scheduled and shall be capable of withstanding all forces which may be imposed during the course of normal operation.

Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the filtered pump media, through the cooling system. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external

cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4"diameter located 180° apart. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104°F). Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.

Provide motors which are capable of operating for extended periods in a dry mode without damage to motor or seals.

Provide motors which are designed, rated and warranted for continuous operation and inverter duty on a variable frequency controller with pulse width modulated output.

Do not provide motors which contain in excess of three (3) gallons of oil (combined total for cooling and seals), or which contain other than ecologically safe paraffin base oil.

Provide motors which are FM listed for use in Class I, Division 1, Groups C&D hazardous locations as defined by the National Electric Code.

2-4.13. Protective Devices. The motor shall be furnished with protective devices mounted in the motor housing, and separate motor protection relays. The motor protective devices shall be compatible with the pump control and status monitor specified below. The temperature ranges, set points, and activation levels shall be as recommended by the pump manufacturer.

Motor protection devices shall include the following:

The motor shall be provided with thermal sensors installed in the motor windings to monitor the motor temperature.

Leakage sensor to detect water in the stator chamber. Leakage sensor shall be of the float switch type.

Lower bearing temperature sensor. The sensor shall directly contact the outer race of the thrust bearing providing for accurate temperature monitoring.

The winding temperature sensors, lower bearing sensors and float switch leakage sensor shall be connected to the motor control circuit to shut down the motor on high winding temperature or seal leakage, as shown on the Drawings. The sensors shall be factory installed and connected to the pump control cable.

The cable entry shall be an integral part of the stator casing. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak-proof, torque free seal at the cable entrance. The

assembly shall bear against a shoulder in the stator casing opening and be compressed by a brass gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion.

Each pump shall include electric power and control cable(s) of the length required for the installation shown on the Contract Drawings plus an additional 10' length for maintenance purposes. The cable shall be resistant to oil, corrosive gases and other materials normally found in sewage service. The cable entry into the motor shall include a sealing by a close tolerance elastomer grommet flanked by stainless steel washers. The cable shall terminate in a sealed junction chamber with a terminal board or terminal block. Power cable sizing shall conform to NEC requirements.

Provide stainless steel cable grips (strain reliefs) as required to support each cable.

2-4.14. Cable Support. The pump supplier shall provide a support and protection system for the power and control cables for each of the pumps supplied. This system shall be a part of, and integrated into each pump unit. The supplier shall assume full responsibility for its function and provide a functional guarantee, as detailed below. The system shall consist of the following components and functions:

Each pump shall be equipped with a fabricated 316 stainless steel yoke that will provide positive location of each of the electrical cables in relation to the pump centerline. The yoke shall also provide a firm grip of each of the cables so that a 100% strain relief is achieved, with a 3.5 minimum margin of safety against slippage. The yoke design shall be such that no cable will contact any part of the pump, or the discharge piping (including the support brackets), during pump installation or removal.

Each yoke shall incorporate parts of the pump gripping and lifting system specified herein and provide for automatic coupling of the pump to the pump lifting device.

Cable support devices shall be supplied and permanently installed in the wet well below the opening by the contractor to permit hook up of the cable grips. These devices shall be capable of supporting the entire length of cables contained within the wet-well, with a safety margin of no less than 3.5.

2-4.15. Guide Rails and Supports. The pump guide rails and rail supports are to be made of 316 stainless steel. Rail supports spacing to be no larger than 5-ft.

2-4.16. Pump Installation and Retrieval System. The pump supplier shall provide a pump installation and retrieval system, designed to operate with the pump models supplied. The system shall be compatible with the pump lifting equipment as shown on the Contract Drawings. The pump supplier shall assume full responsibility for its function. The pump installation and retrieval system shall consist of the following components and functions:

Each pump shall be equipped with an oversized lifting bail, made from high strength alloy steel and attached to a fabricated 316 stainless steel cable support yoke. The lifting bail shall be designed to operate with the pump installation and retrieval system.

Each pump installation and retrieval device shall be automatically guided down the pump guide bars as the station hoist lowers the device down towards the installed pump. When meeting the top of the pump it shall automatically and securely engage the pump lifting bail when coupling to the pump. There shall be no possibility for inadvertent or unintentional release of the lifting mechanism while a pump is lifted.

After a pump is placed upon the service deck, a manual release of the swiveling hook shall be required.
When a pump is to be installed, a separate hook release device shall be temporarily added to the lifting mechanism. This device shall provide that once a pump is seated on the discharge connection, the attached lifting device can be automatically released and brought back up the guide rails with the station hoist. Lifting devices that do no guarantee a 100% positive lock, without the benefit of a line of sight or multiple cable arrangements, shall not be considered equal. No personnel shall be required to enter wet well and no permanently attached lifting cables or chains are allowed.

The pump installation and retrieval system shall be fabricated from alloy steel, have a load rating of no less than 10,000 lbs. and be coated with one part epoxy paint systems in the same color as the pumps.

2-5. SHOP PAINTING

2-5.01. With the exception of those parts and components customarily furnished unpainted, all metal surfaces shall be shop prepared and coated with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified. Machined surfaces shall be protected against damage and corrosion by other means.

2-5.02. Surface preparation and application of the shop paint coating shall be as specified in Section 09940 Protective Coatings

2-6. SOURCE QUALITY CONTROL

2-6.01. Perform shop testing in accordance with the requirements of the Hydraulic Institute latest manual.

2-7. SPARE PARTS Spare parts for the pumping equipment as listed below shall be provided in the quantities listed for each size of pump:

1. One set of pump bearing assemblies.
2. One pump shaft sleeve.
3. One impeller with wear ring attached.
4. One set of impeller and case wear rings with screws.

5. One set of motor bearings.

2-7.01. Packaging and Labeling. Spare parts listed to be furnished shall be packed in wooden boxes, labeled with the manufacturer's name, address and telephone number; local representative's name, address and telephone number; name of equipment the parts are for and list of parts contained therein.

2-8. PUMP MOTOR INTERFACE CONTROLS

2-8.01. General. The pump manufacturer shall furnish pump motor protection relays required for the submersible pump motor protection functions specified above, for mounting in the pump motor controller specified in Division 16.

Adjustable frequency drives shall be provided and shall be coordinated with the requirements of the pumping unit. The pump manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

Adjustable frequency drives shall be design as specified in the Adjustable Frequency Drives section.

2-8.02. Pump Control and Status Monitor. Each pump shall be provided with a self-contained control and status monitor designed for use with the motor protective devices provided. The unit shall monitor stator temperature and leak detection. In the event of an alarm condition, the monitor shall provide relay output control interlocks and alarms to provide control functions as shown on the Contract Drawings.

The monitor shall be provided with the following features:

a. Supply Voltage: 24 VAC
b. Input Channel: Monitors high temperature and leakage conditions.
c. Output Relays: Common alarm output relay
Alarm interlock output relay
Contacts rated 8 amperes at 120 VAC.
d. Status LEDs: Yellow for supply voltage presence
Red for Over temperature Indication
Red for Leakage Indication
e. Alarm Reset: Manual reset input channel
f. Mounting: Suitable for 11 pin relay socket mounting.

Wiring connections for control and status monitor shall be as shown on the Contract Drawings and as recommended by the pump manufacturer. Basis of the motor control wiring shown on the Drawings is Flygt Min-CAS II. Other manufacturer's products will be

accepted on the condition that any motor control wiring changes that are required to accommodate another product will be provided at no additional cost to the Owner.

The monitor shall be configured by the pump manufacturer prior to startup of each pump.

2-8.03. Spare Parts. Provide three spare pump control and status monitors to the CSI, who shall turn them over to the Owner. Spare parts shall be wrapped in weather-proof packaging and labeled to reflect the associated equipment systems.

PART 3 - EXECUTION

3-1. INSTALLATION

3-1.01. Install pumps and accessories in accordance with the configuration shown on the Contract Drawings.

3-1.02. Prior to grouting, pump and pump motor base plates shall be leveled with metal shims in accordance with Hydraulic Institute Standards. Wedges will not be allowed.

3-1.03. Contractor shall coordinate with the Manufacturer to determine the pump benching and suction baffles. Contractor shall form and construct pump benching as recommended by the Manufacturer and will follow Hydraulic Institute standards. Pre-formed benching is acceptable if recommended by the Manufacturer.

3-1.04. The baseplates shall be grouted after initial fitting and alignment but before final bolting of connecting piping. The Contractor shall maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignments and bolting, pump connections shall be tested for applied stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

3-1.05. All bearings shall be lubricated according to the manufacturer's instructions and all adjustments made to suite anticipated operating conditions.

3-2. FIELD PAINTING

3-2.01. Field painting shall be in accordance with Section 09940 Protective Coatings.

3-3. FACTORY TESTING

Factory-test pumps, variable speed drives, and motors, 150 hp and larger, as complete assembled systems in accordance with the indicated factory test procedure and witnessed by the OWNER and ENGINEER.

Give the ENGINEER a minimum of 4 weeks notification prior to the test.

3-3.01. Costs for OWNER and ENGINEER, shall be borne by the CONTRACTOR and shall be included in the Contract Price, including travel and subsistence costs for 2 people excluding salaries.

Submit test results to the ENGINEER.

No equipment shall be shipped until the test data have been approved by the ENGINEER.

3-3.02. Conduct the following tests on each indicated pump system:

Motors: Test electric motors in accordance with manufacturer's recommendations. Furnish test results to the pump manufacturer prior to the pump test.

Variable Frequency Drives: Test variable frequency drives in accordance with the requirements of Section 16150 Adjustable Frequency Drives.

Furnish test results to the pump manufacturer prior to the pump test.

3-3.03. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.
3-3.04. FIELD TESTING Field-test each pump system after installation in order to demonstrate:
Satisfactory operation without excessive noise and vibration;

No materials loss caused by cavitation;

No overheating of bearings; and,

Indicated head, flow, and efficiency at the design point.

Conduct the following field testing: Startup, check, and operate the pump system over its entire speed range.
If the pump is driven by a variable speed drive, test the pump and motor at 100-RPM increments.

Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute standards at a minimum of 4 pumping conditions defined by the ENGINEER.

Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for a least 4 pumping conditions at each pump rotational speed, at 100-RPM increments if equipped with a variable speed drive or at maximum RPM if equipped with a constant speed drive.

Check each power lead to the motor for proper current balance.

Bearing Temperatures: Determine bearing temperatures by a contact-type thermometer.

Precede this test with a run time sufficient to stabilize bearing temperatures, unless an insufficient liquid volume is available to furnish such a run time.

Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.

Witnessing: Field testing will be witnessed by the ENGINEER. Furnish 3 Days advance notice of field testing.

If the pumping system fails to meet the indicated requirements, modify or replace the pump and re-test as indicated above until it satisfies the indicated requirements.

Certification: After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.
Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.

The CONTRACTOR shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear.

If available, the OWNER's operating personnel will provide assistance in field testing.

3-4. MANUFACTURER'S FIELD SERVICE

The supplier shall furnish the services of a factory-trained representative. Service shall be provided as necessary after the Contractor has installed the equipment.

These services shall be furnished for the purposes of the equipment manufacturer's inspection of the equipment following installation, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner's personnel in operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.

The Contractor shall coordinate the Manufacturer's technical services in a timely professional manner. At a minimum, two weeks notice must be given to the Manufacturer for travel planning purposes unless previously agreed by Manufacturer. To avoid project delays, every effort should be made to coordinate inspection, training, and start-up of the equipment.

After inspection of the installed equipment the Manufacturer shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by anchorage, has been operated under full load conditions and that it operates satisfactorily.

3-4.01. Provide manufacturer's services at the jobsite or classroom designated by the Owner for the minimum hours listed below, travel time excluded:

A. Manufacturer shall include a minimum of two (2) two-day trips, exclusive of travel time, for the purpose of supervising installation, start-up and instruction of Owner's personnel in proper operation and maintenance.

B. Minimum services to be provided by manufacturer's factory representative while on site:

1. Observe, inspect and approve installation – 1 day.
2. Supervise initial adjustment – 1 day.
3. Supervise field run test – 1 day.
4. Instruct Owner in proper start-up and O&M – 1 day.

End of Section

Section 11330

COARSE SCREEN

PART 1 - GENERAL

1-1. RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1-2. SUMMARY:

The work under this section includes, but is not limited to, installing and placing into successful service two fully automatic multi-rake bar screens for collecting and removing debris from the incoming wastewater flow by specified bar screens.

Each screen shall be furnished complete with bar rack, dead plate, , side frames, covers, rake blades, drive chains, sprockets and bearings, scraper assembly, drive motor, gear reducer, anchor bolts, controls and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.

All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, startup, and satisfactory operation of the system. Any re-design required to accommodate an equal proposal shall be borne by the Contractor at no additional cost to the Owner.

Where indicated on the drawings, all equipment shall be rated for use in a Class 1, Division 2 area.

1-3. DEFINITIONS/STANDARDS

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:

1. American Society for Testing and Materials (ASTM)
2. National Sanitation Foundation (NSF).
3. American Society of Mechanical Engineers (ASME).
4. National Electrical Manufacturers' Association (NEMA).
5. National Electrical Codes (NEC).
6. Underwriters Laboratories (UL).

1-4. SUBMITTALS

1-4.01. Product Data: Complete engineering data including, but not limited to, descriptive data, material specifications, motor performance data, piping diagrams, and wiring diagrams. Differentiate between manufacturer-installed and field installed wiring.

1-4.02. Shop Drawings: Complete layout and connection drawings including plan, elevation, sections, and details.

Certified shop and erection drawings showing important details of construction dimensions, anchor bolt locations, and field connections.

Control panel schematics and layout drawings.

Descriptive literature, bulletins, and catalogs of the equipment, including details of the motor, gear reducer and lubrication points.

Installation, operation, and start-up procedures including lubrication requirements.

Complete motor data in accordance with the Common Motor Requirements for Process Equipment section.

Total weight of the equipment including the weight of the single largest item.

A list of spare parts that are supplied by the equipment supplier.

1-4.03. Operation and Maintenance Manuals: After approval of shop drawings, submit operation and maintenance manuals in accordance with Division 01 Section 01730 –

Operation and Maintenance Information. A complete description of the warranty to be provided

Performance Affidavit. At the time of submission, the manufacturer shall, in writing, call the Owner’s and Engineer’s attention to any deviations that the submittal may have from the requirements of these specifications.

All material submitted for review shall be contained in one submission. Partial submissions will not be reviewed. Sales bulletins or other general publications are not acceptable for review, except where necessary to provide supplemental technical data.

1-5. QUALITY ASSURANCE.

Qualified suppliers will have a minimum 5 years’ experience manufacturing equipment similar to these specifications. Supplier will provide a list of names and dates of 3 installations of similar size located in the United States for verification by the Engineer or Owner's Representative.

Alternate Manufacturers: The Drawings and Specifications use Huber Technologies Inc.as the "basis of design equipment" due to the complexity of the influent screening

system. This is not intended to restrict competition or rule out comparable competitive alternate influent screening systems that may have certain features not affecting the basic operation of the equipment, but is for the purpose of establishing the desired standard of quality and features.

All parts of the equipment provided to be designed and manufactured for long, continuous and uninterrupted service. All materials used to be of best quality and entirely suitable for service required.

Unless otherwise specified in these specifications, the entire equipment shall be manufactured from 316 stainless steel shapes (rods, angles, and channels), pipes, and sheets. All mechanical parts shall be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according, under the conditions specified to the O&M manual.

Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.

1-6. DELIVERY, STORAGE, AND HANDLING

Items to be shipped as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.
Protect equipment during storage and shipment in accordance with the manufacturer's recommendations.

Protect the equipment from being contaminated by dust, dirt, vibration, moisture, heat and cold temperatures.

The screening unit shall be erected and lubricated in strict accordance with the instructions of the Manufacturer's field engineer.

Spare Parts shall be packed in containers, labeled clearly with part number, designated contents, and pieces of equipment.

1-7. WARRANTIES AND BONDS

Contractor shall provide a warranty against defective or deficient materials and workmanship in accordance with the requirements of Division 01.

The equipment manufacturer shall provide a warranty against defective or deficient equipment, workmanship and materials. The warranty shall be in accordance with the General Conditions.

PART 2 - PRODUCTS

2-1. MANUFACTURERS

The coarse bar screens shall be in compliance with these specifications, drawings and shall be supplied by one of the following manufacturers:

1. Huber Technology, Inc.
2. Headworks International.
3. Enviro-Care.
4. Or Equal.

Manufacturers must have had the screen and controls, tested by an independent facility to ensure satisfactory in similar operation.

2-2. MULTI-RAKE BAR SCREEN SYSTEM

The bar screen shall remove debris (screenings) from the incoming wastewater by means of a positively cleaned bar rack that is installed in a concrete channel. The screen shall retain debris at the bar rack. A multitude of rake blades shall remove and lift the debris to a discharge mechanism. The bar rack shall be cleaned by a series of rakes engaging the bar rack from the upstream side (front) at the bottom of the channel and then moving up along the bar rack. The debris shall be lifted above the channel and dropped on a discharge chute at the downstream side (back) of the screen. The discharge chute shall be field fabricated by the Contractor as shown in the drawings. Screens with single rakes shall not be approved.

All components shall be so designed that jamming at any point will not result in structural failure, but will cause the drive motor to stall. All components, including the gear reducer, shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor and/or the maximum differential head at any channel water depth.

All stainless steel components and structures shall be submerged in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Sand blasting, bead blasting, spray pickling or hand pickling of stainless steel surfaces shall not be acceptable. All stainless steel shall be 316 stainless steel unless otherwise noted.
Design Criteria:

1. Number of Screens: 2
2. Max Flow Per Screen: 50 MGD
3. Bar Clear Opening Size: ½”
4. Approximate Channel Width: 60”
5. Screen Inclination: 85°, See Drawings
6. Rake Travel Speed: 26-39 ft/min
7. Maximum Upstream Water Level: 71” above channel bottom.*
   *The screen shall be capable of handling the maximum flow without exceeding the maximum upstream water level based on 30% reduction of the screens free open-area.

2-3. COMPONENTS:

Bar Rack: The bar rack shall consist of equally spaced, straight bars that are inclined from the horizontal with the inclination angle specified above. The lower ends of the bars shall be provided with a base plate such that the rakes positively remove all screenings from the bottom of the bar rack. The bars shall be teardrop shaped or have a triangle cross section with a bar opening of ½". The bar rack shall be made up of equally sized sections securely fastened to the frame of the screen and be readily removable.

Frame: A frame shall be provided supporting all required loads. Side frames shall be made of stainless steel plates with a minimum of four axial edges. The side frames shall be connected with each other through channels. The side frames shall be connected to support frames. The support frames shall be securely anchored onto the operating floor.

Each side frame shall include separate roller tracks to guide the rakes. The roller tracks shall be bolted to the frame so that they can easily be replaced.

Stainless steel shall be fastened to the side frames to seal the lateral gaps between the side frames and the channel walls.

Stainless steel guards shall be provided bolted to the screen frame and partially cover the lower sprockets to provide protection from large debris.

Rake: The rake blades shall be bolted on the rake bar or links. The rake blades shall have teeth matching and engaging the bars of the bar rack. The rake blades shall each consist of several pieces with teeth such that only one of the pieces needs to be replaced in case that a tooth should be damaged.

The rake assembly shall be driven by an electric motor in accordance with the Common Motor Requirements for Process Equipment section. The motor shall be inverter duty rated, 3.0 hp, 460 Volts, 60 Hz, 3-phase. The motor shall be rated for operation in a 104 degree F environment.

Drive Chains, Bearings, and Sprockets: Drive chains/links for the rakes shall be roller type chains and shall have links made from 316L stainless steel. The chain/links bushes and pins shall be made from stainless steel. Each chain shall be rated for a maximum load of no less than 120,000N (26,977lbs.f). Drive chains, chain guides, sprockets and their bearings shall be replaceable without the need for removing the screen from the channel.

Upper bearings shall be flange bearings, and shall be provided with grease nipples for easy lubrication. The bearings shall be designed for use with biodegradable grease. The casing shall be made of stainless steel.

Lower bearings shall be slide bearings in a stainless steel casing. They shall include white cast iron shafts and silicon carbide slide bushings.

Each screen shall be provided with four sprockets. The lower sprockets shall be solid. The upper sprockets shall be split to facilitate maintenance. Upper nonsplit sprockets are acceptable. The sprockets shall be made of stainless steel plates.

Drive Shaft and Rocker Arm: The drive unit shall be designed for continuous service and intermittent spray water contact. The drive shaft shall include an integral rocker arm assembly on the drive end that flexes if the screen rakes get jammed.

The rocker arm assembly shall consist of a drive unit mounted to a stainless steel arm. The stainless steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The flange bearing shall be connected to the rocker arm by four bolts. The rocker arm position shall be maintained in the standard operating position by the two tension springs. An intrinsically safe proximity switch shall be provided in accordance with Division 17 requirements and shall indicate the position.

Scraper Mechanism: A pivoting scraper mechanism shall be positioned at the point of discharge and shall be attached to the side frames. The scraper shall clean the rake on each pass and return to its rest position with minimal shock. The scraper shall be designed such that screenings do not wrap around the rake or scraper. The scraper shall be provided with a scraper bar and an adjustable thick wiper made of Polyethylene or UHMW. The scraper shall be connected with the frame through a pair of long scraper arms. A pair of shock absorber elements shall be provided.

Discharge Chute: A discharge chute shall be provided that fully encloses the discharge section of the screen. An access hatch with hinges and a handle shall be provided in the chute permitting easy access. The discharge chute shall be mounted to direct screenings into existing belt conveyor. The chute shall have a slope of minimum 60 degrees. The discharge chute shall be field fabricated by the Contractor as indicated in the drawings.

The bar screen shall be provided with a dead plate extending from the bar rack to the discharge chute. The dead plate shall be made of a stainless steel plate and shall be stiffened by structural members so that it is flat without undulation so that the tips of the rake's teeth ride up and over the dead plate. The dead plate shall be securely fastened to the side frames.

Cover: The screen shall be provided with easily removable, sufficiently stiffened covers made stainless steel plates with edges on all sides. The covers shall be provided with turn locks and handles

2-4. CONTROLS AND INSTRUMENTATION:

Water Level Sensors: Bar screen manufacturer shall provide ultrasonic level sensors with transducers for each bar screen for continuous monitoring of the upstream and downstream water levels for control of screen operation. The transducers shall be rated as per requirements of 17500, rated for Class1 Division 2 hazardous locations and shall be intrinsically safe without the use of additional barriers. The transmitter shall be

mounted next to the main control panel. Contractor shall install the transducers and provide wiring to the control panel.

Control Panel: A single main control panel shall be provided for each train per requirements of 17500, 17570, 17561 and 16050 shall be furnished with a lockable NEMA 4X corrosion-resistant stainless steel enclosure together with all required local control station(s) rated for a NEMA 7, Class 1 Division 2 environment as shown on drawings.

Main control panel shall be integrated into a single control system for each process stream channel as shown on drawings. Control panels shall be constructed per requirements of 17570 by a U.L. listed company and shall bear a U.L. label. Controls and motor starters shall be included in design of main control panel.

Control panel wiring shall be color coded, neatly cabled and supported in non-flammable wiring tracks. Wiring shall be minimum 14 gauge MTW stranded wire per requirements of 17570. Main control panel shall include the following:

1. 600-Volt rated main circuit breaker disconnect with lockable handle
2. 480 – 120 Volt control power transformer
3. Reversible Screen VFD, compatiable with VFD listed in Division 16.
4. Local-Off-Remote selector switch for the operation of the bar screen drive
5. FORWARD-OFF-REVERSE selector switches for use in LOCAL operation. Switch shall spring return from REVERSE to OFF
6. Red pilot light for “Screen Run” indication
7. Amber pilot light for “Fault” indication
8. Amber pilot light for “High Water Level” indication
9. White pilot light for “Control Power” indication
10. Alarm silence and reset push buttons
11. Push-to-Stop/Pull-to Run emergency stop maintained push button with lockout
12. Dry contacts for remote indication of “Fault”, “Screen Running”, and “High Level”
13. Control relays, wiring and circuitry required to implement the control logic
14. High Level Float switch
15. Programmable controller (PLC) per requirements of 17500 and all applicable sub-sections
16. Operator interface to provide following:
    a. Display of current fault
    b. Alarm History
    c. Motor Hour Meter
    d. Operator access to user adjustable set points

Sequence of Operation: In Remote Auto Mode the screen shall be controlled by the water level sensors. Screen operation shall be started when the water level sensors monitor a certain water level difference, when the ultrasonic level sensor detects high water level, or when a certain time has passed since the last operation of the screen. Screen operation shall be stopped with an adjustable delay time after the water difference is below a certain value and after the ultrasonic level sensor ceases to indicate high water alarm, or after a certain run time has expired (if operation was started by timer).

If applicable: If the screen rakes experience a jam, the force will cause the rocker arm described above to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to enter a self-clearing mode. The self-clearing mode with attempt to reverse the direction of travel of the rakes for a set period before resuming forward operation. This cycle will be attempted up to three (3) times; if the self-clearing mode should prove unsuccessful then the system shall initiate an alarm signal.

Reset is manually performed after correction of any cause for a trip-out.

With LOR in LOCAL position the operator shall be able to run the rake assembly selecting the respective FORWARD or REVERSE direction from the FORWARD-OFF-REVERSE selector switch.

2-5. SPARE PARTS

The Manufacturer shall furnish the following spare parts for the coarse screens as applicable:

1. Two (2) set of rake plates
2. Two (2) lower bearing assemblies
3. Two (2) wipers for scraper
4. Two (2) proximity switches
5. Two (2) spare chain segments (2000 mm length)
6. One (1) Drive Motor and gear reducer

If screen requires parts listed below, the Manufacturer shall provide the following spare parts.

7. One (1) drive clevis pin
8. Ten (10) snap/retaining rings
9. Two (2) link clevis pins
10. Two (2) scraper bolts
11. Two (2) Scraper nuts
12. One (1) snap ring tool
13. One (1) Never Seez 3 oz. tube

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

PART 3 – EXECUTION

3-1. INSTALLATION

Installation of the equipment shall be in strict accordance with the contract documents, shop drawings, manufacturer's instructions and operation and Maintenance Manuals and/or any pre-installation checklists. The manufacturer shall furnish the anchor bolts for the equipment. It is the Contractors responsibility to install the anchor bolts in accordance with the manufacturer's recommendations.

Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Owner and Engineer of significant deviations.

3-2. TESTING & START-UP

After completion of installation, Contractor shall provide for testing and shall be performed in strict conformance with the manufacturer's start up instructions. Testing of the bar screen shall demonstrate that the equipment is fully operational by picking up and depositing materials into specified containment.

Manufacturer shall furnish the services of a factory-trained service engineer for a minimum of one (1) trip including a total of five (5) days to inspect the installation, observe start up, and provide operator training in accordance with Section 01664 for the coarse screening equipment. It shall be the responsibility of the Contractor to coordinate Manufacturer visits with the Owner. If all required testing, startup, and training is not completed during the allowable time frame, additional Manufacturer visit will be required at no additional cost to the Owner. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the manufacturer's technician present.

Field certification shall include but is not limited to the inspection of the following:
Inspect and verify location of anchor bolts, equipment placement, leveling, alignment and field erection of equipment, as well as control panel operation and electrical connections.

Make all necessary adjustments and settings to the controls.

Provide classroom and/or field training on the Operation and Maintenance of the equipment to operator personnel. These instructions may include the use of slides, videos, literature, and/or oral presentations.

The installation services shall be coordinated between the Contractor and the Manufacturer. The Contractor shall coordinate the start-up and field testing services, and the O&M services with the Owner and Engineer.

All costs, including travel, lodging, meals and incidentals for manufacturer service shall be included in the Contractor's bid.

End of Section

SECTION 11387

PERISTALTIC HOSE PUMPS

PART 1 – GENERAL

1-1. DESCRIPTION

1-1.01. Scope. This section specifies positive displacement peristaltic hose type pumps for use in sludge and scum pumping applications, complete with electric motors, adjustable frequency drive and appurtenances as specified herein. The Contractor shall assign unit responsibility to the pump manufacturer for all equipment and appurtenances specified in this section.

Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor the exact dimensions particular to any manufacturer's equipment. The manufacturer shall review the mechanical layout drawings to familiarize themselves with the location and set-up of the equipment specified and shall assure themselves that the equipment specified is appropriate for and coordinated with what is shown on the contract drawings. Due to physical space constraints, consideration must be given to pump arrangement and equipment access for pump maintenance and hose replacement. At minimum, the equipment clearances and tolerances as shown on the drawings shall be maintained during installation.

The manufacturer shall also review the relevant electrical plan and one-line diagram and the relevant process and instrumentation diagram drawings to ensure that the contract drawings are appropriate and coordinated with the equipment controls specified and the monitoring and protection devices shown on the P&ID.

Pump manufacturer shall be responsible for coordinating and checking the compatibility of the harmonic frequency of the AFDs with the pump motors to achieve the desired variable speed operation of the pumps.

Sludge pumps shall be able to accept and use hoses standard 100-millimeter internal diameter hoses with a wall thickness of 22 millimeter made from natural rubber, hypalon, Buna N or EPDM materials. Hose replacement shall be possible from either the suction or the discharge ports. The hose shall be of 53-68 durometer with a static burst pressure of 600 psi.

Pumps shall be reversible type and shall be able to rotate in either direction without any reduction in pumped flow or pump efficiency. Running the pump in reverse direction for hose replacement or unclogging of the pump suction lines shall be considered as part of the routine operation and shall not cause the pump warranty to be voided.

1-1.02. Type. The pumping units shall be of the positive displacement, peristaltic hose type specifically designed for pumping wastewater treatment sludge and scum containing organic solids and small inorganic particles.

1-1.03. Equipment List.

Item	Equipment No.
SRWRC Primary Sludge Pumps	PPS-20, PPS-30, PPS-60, PPS-70, PPS-80 (Additive Alternative)
ICWRC Ferric Chloride Pumps	Section 11727

1-1.04. Primary Sludge Pump Operating Conditions. Equipment shall be specifically designed and selected for continuous duty pumping of solids derived from the treatment of wastewater. Pumps shall be suitable for exposure to primary sludge containing grit, tramp iron, small particles of wood, industrial solvents, greases, detergents, petroleum products, and organic particles in concentrations as great as 7 percent. Pumps shall be of a horizontal, positive displacement, simplex peristaltic hose type pump design with pump head, planetary speed reducer, and drive motor mounted on a common baseplate.

Primary Sludge Fluid Properties	Expected Range
Percent Solids, %	1 to 7
Specific Gravity	1.01 to 1.05
Temperature, deg F	55˚ to 85˚
pH	4.0 to 8.0

The sludge pumps will be operated at variable speed in response to the control system specified in Division 17 specifications. Ultrasonic sludge blanket monitors will be installed on each clarifier and the sludge pump speed will be adjusted automatically based on the respective sludge blanket levels. Pump speed may also be adjusted manually.

1-1.06. Performance and Design Requirements. Pumps provided under this specification shall be designed for the following operating requirements.

Equipment Number	AFD	Suction and discharge port size, in	Inner Hose Diameter, Inches	Suction pressure, feet (neg.= suction lift	Average capacity/ head (Continuous Duty)		Peak capacity/ head		Maximum motor speed at peak capacity, rpm	Maximum motor HP
					gpm	feet	gpm	Feet		
Primary Sludge Pumps:	Yes	4 inch suction 4 inch discharge	4 inches	10	100	25	150	168	1800	20

1-2. QUALITY ASSURANCE

All hose pumps supplied are to be the product of one manufacturer. Pumps are to be manufacturer's standard catalog product. Shop tests shall be as specified in this section.

Pump manufacturer must provide pumps and accessories, which are integral to pump operation, and specified herein as a coordinated package, regardless of manufacturer. This includes pumps, gear reducers, motors, pulsation dampeners, leak detectors, variable frequency drives and other such accessories specified under this section as the responsibility of the pump supplier. Equipment specified herein that is not supplied by the pump manufacturer, as an integrated package will be rejected.

1-2.01. References. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AGMA 2000-A88	Gear Classification and Inspection Handbook
ISO 9001 2008	Quality Management Systems – Requirements
ASME Y14.36M-1996	Surface Texture Symbols
ASTM D2240 - 05(2010)	Standard Test Method for Rubber Property – Durometer Hardness
ASME/ANSI B16.5 – 1996	Pipe Flanges and Flanged Fittings
ASTM A48/A48M - 03(2008)	Standard Specification for Gray Iron Castings
ASTM A1011 / A1011M – 10	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
NEMA MG1-1993 Revision 1	Motors and Generators, Revision 1

1-2.02. Unit Responsibility. The Contractor shall assign the unit responsibility to the manufacturer of the Peristaltic Hose Pumps provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility for both the equipment assembly specified in this section and for the motors and the variable frequency drives, and all other equipment assembly components specified elsewhere but referenced in this section. A completed, signed, and notarized Certificate of Unit Responsibility shall be provided.

1-2.03. Factory Testing. Perform non-witnessed inlet vacuum testing as follows:

1. Test assembled pump running on air.
2. Run test for a minimum of 30 seconds and record vacuum reading which must meet or exceed 28" Hg vacuum.
3. In the event that specified tests indicate that the pump does not meet specifications, Engineer has the right to require complete tests for the pump at no additional cost to the owner.
4. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
5. Repeat tests until specified results are obtained.

1-3 SUBMITTALS

1-3.01. Submittal Data. The following information shall be submitted in accordance with the General Conditions:

A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts unit responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

Catalog information for all components, materials lists, and additional information describing the conformance of the proposed equipment with the design and operating requirements of this section.

Motor information as required by the Common Motor Requirements for Process Equipment section.

System layouts and/or schematics.

Elementary and connection wiring diagrams clearly showing external connections to other equipment.

Applicable operation and maintenance information as specified in Section 01800.

Dimensioned mechanical layout drawings showing the proposed equipment with suction & discharge piping, pulsation dampeners and all valves & appurtenances. Indicate and confirm adequate maintenance space for the pumps, motor and hose replacement. Dimensioned layout drawings shall show the relative position of the equipment being provided with respect to the adjacent structure (primary sludge pumping station) and indicate the clearance between the wall and the pump and two adjacent pumps.

Equipment performance data including pump characteristics curve for each type/model of pump being proposed. Curves shall include HP vs. Flow (gpm) and speed (RPM) both as a function of discharge pressure (psi) for the entire range of the manufacturer's recommended operating range. Separately note displacement per revolution; minimum and maximum; and recommended continuous and instantaneous flow by the manufacturer.

Data and specification sheet on the inductive revolution sensor. Include instrument mounting details with the submittal.

Complete bill of materials listing each component and its material of construction and weights.

Data and specification sheet on the high lubricant level sensor. Include instrument mounting details with the submittal.

Provide operation and maintenance information for each type and size of gear box. Provide detailed parts list, materials of construction and dimensional drawing for each type of gearbox proposed. Include gear reducer catalogue sheets and data sheets including service factor, efficiency and torque rating for each type of gears provided. Gear reducer life certified by the manufacturer.

Structural analysis of the pump shaft and Pump bearing life certified by pump manufacturer.

Drive catalog cut sheets and data sheets including drive efficiency, input and output RPM for each type of drive supplied.

Structural analysis at the pump mounting frame and base plate including loading and stress on all structural components.

List of external utility requirements such as air, water, power, drain, etc. for each component.

5-year warranty information and certificate indicating that the use of non-OEM hose and lubricant with the pumps will not void the warranty. Indicate the required preventative maintenance to be performed by the owner during the warranty period and documentation required.

Information on the lubricant and coolant including the MSDS and the quantity required for each type of pump.

Submittal for the flexible metal hose connector.

Equipment data sheet for each size of pulsation dampeners being provided. Indicate on the data sheet the location (suction and discharge) and the associated pumps.

1-4. ENVIRONMENTAL CONDITIONS

1-4.01. Equipment specified in this section will be located indoors in the primary sludge pumping house building with ambient temperature ranging from 32 degrees F to 90 degrees F. Pumping equipment may be subjected to relative humidity's up to 100%. Liquid being pumped may contain oils, grease, organic and inorganic solids and high level of hydrogen sulfide.

1-5. DESIGN CRITERIA AND EQUIPMENT ARRANGEMENT

The pump units shall be capable of the specified discharge capacity and heads when operating at the suction conditions, fluid temperatures, and specific gravities as listed in Section 1-1. The pumps shall be electric motor driven. Motors shall be severe duty motors.

Simplex pumps shall have the motors connected horizontally to the pump rotor by an in-line gear box. Pump motor shall be independently supported from the base plate to transfer the motor load to the floor rather than cantilevered load on the gearbox and the pump housing. Motor support shall be adjustable and motor shall rest freely on the support.

The manufacturer shall submit detailed mechanical layout and sections of the pumping stations showing the pumping equipment with the suction and discharge piping and all other appurtenances and piping supports as part of the equipment submittal requirements as specified in paragraph 1-3. Detailed layout drawings shall also indicate the minimum space requirements for hose replacement and equipment maintenance around each pump. If the design engineer determines that proposed pump arrangement does not provide the adequate space around the pumping equipment, the manufacturer shall reconfigure the simplex pumps with right-angle gear boxes and arrange the motors vertically to reduce the pump footprint. For the vertically mounted motor arrangement for simplex pumps, the motor and gear box shall be supported

independently such that the no cantilever load is transferred to the pump housing and/or the pump shaft.

1-6. WARRANTY

Contractor shall provide a one year standard warranty in accordance with the General Conditions against defective equipment and poor workmanship.

1-6.02. In addition, Contractor shall also provide the Owner with an extended limited warranty for the hose pump including rotors, motor, bearings, seals and the gear box provided as part of this Section and in accordance with all performance criteria ("Equipment"). The warranty shall bind the Equipment manufacturer or the unit responsibility supplier for the Equipment specified in this Section. In addition, Contractor shall provide a maintenance bond for 100 percent of the replacement cost and installation of the Equipment. An irrevocable letter of credit in a form acceptable to the Owner from a U.S. Federally insured banking institution may be submitted in lieu of the maintenance bond in an amount equal to the required maintenance bond. The warranty must be supplied to the Owner by the Contractor prior to start-up of the equipment and must be in a form acceptable to the Owner. The warranty required by this Section shall include all costs for labor, material, equipment, delivery, installation, fees, taxes or other costs associated with the purchase, replacement and installation of the Equipment in the event of a failure of the Equipment in accordance with the Contract terms, including without limitation failure of gear box, pump shaft or persistent failure of the pump bearing and seals during the warranty period. The warranty period shall commence after final acceptance and Final Completion of the Agreement, as certified by the Owner pursuant to the Agreement documents and continue for a period of 5 years. For purposes of the Equipment, Final Completion shall not be reached until the Owner has certified that the equipment has successfully performed in accordance with all applicable performance standards and specifications under the Agreement, including satisfactory performance testing and periods. Use of hoses and /or lubricant from other manufacturers (non-OEM) shall not cause the equipment warranty to be voided.

1-6.03. Warranty shall also include an annual checkup and annual bearing(s) and seal(s) maintenance of each pump, by the manufacturer’s certified trained professionals at the site. All labor and Travel & Living costs shall be included as part of the equipment warranty. Owner shall be responsible for performing normal and preventative maintenance schedules per manufacturer’s recommendations and maintaining necessary documentation for it.

1-7. STORAGE AND PROTECTION

1-7.01. Shipment, Protection And Storage. The equipment shall be protected during shipment and storage as specified in Section 01610 and 01611. Pump suction and discharge ports shall be provided with plugs. Each pump shall be secured to a wooden skid to facilitate handling and storage.

1-7.02. While on site, the pumps and accessories shall be stored and protected in accordance with the manufacturer's recommendations and requirements of Section 01610.

PART 2 – PRODUCTS

2-1. ACCEPTABLE PRODUCTS

2-1.01. Peristaltic hose pumps shall be Watson-Marlow/Bredel SPX-100 Series or Verderflex VF125 Series, modified as necessary to provide the specified features and to meet the specified design and operating conditions. All hose pumps shall be the product of one (1) manufacturer.

2-2. EQUIPMENT

2-2.01. General. The pump shall conform to the following general requirements: Pump shall be horizontal, positive displacement, peristaltic hose type.

Pump shall be capable of operating in either direction without flow variation.

Pump shall be capable of running dry and passing solids one half inch smaller than the internal bore of the hose without damage to pump or hose.

Pump shall be capable of pulling 95% of full vacuum and be capable of self priming at negative suction head.

Repeatability: + 1% accuracy.

Valveless/glandless design with no dynamic seals in contact with the pumped media.

Pump shall be capable of being rotated in 90-degree increments for four (4) different port-mounting configurations.

Direct coupled gear drive arrangement as specified herein.

Pump hardware not exposed to corrosive liquid or vapor shall be AISI 304 stainless steel.

2-2.02. Hose and Lubricant. Hose shall be manufactured of three-layer elastomer with an extruded inner wetted layer compatible with the process fluid, four layers of nylon reinforcement, and a Natural Rubber outer layer. Hose outside diameter shall maintain a wall thickness within + 0.25 mm tolerance. Hoses shall have a smooth extruded internal surface and have tolerance controlled through machining.

Minimum Static Burst Pressure rating of 800 psi.

Hose hardness rating shall be 53-68 shore A durometer.

Hose must be replaceable without cover or pump removal.

Pump housing shall contain a NSF-listed food-grade glycerin based hose lubricant blended to provide a medium for cooling and lubrication. Manufacturer will ship the pump with sufficient lubricant to meet the minimum level shown on the housing. Manufacturer will supply additional lubricant required to raise the lubricant level to half way on the housing, for field installation following pump installation. The additional lubricant will be a part of the pump supply contract and will be separate from the spare parts.

Provide a threaded drain plug at the lowest point of the pumping chamber to allow the complete drainage of lubricant. Provide a threaded fill plug at the high point in the pump housing to fill the lubricant while cover plate is installed. Install a ¼ turn valve at the housing drain point with a plug installed in the valve outlet.

2-2.03. Pump Housing With Internal Bearing Frame. Pump housing shall be constructed of Cast Iron ASTM A48 Class 25 and shall be supplied with an internally mounted bearing hub and rotor assembly. Gear unit shall be direct coupled to the back of the pump housing and shall be completely isolated from the process fluid and pump lubricant through the sealed bearing hub. Gear unit and drive components shall be serviceable without removal of pump rotor. Lifting hooks shall be provided on each pump face as well as on the motors.

Rotor shall be constructed of Cast Iron ASTM A48 Class 25 with two pressing shoes mounted 180 degrees apart. Shoes shall be constructed of epoxy or extruded aluminum as recommended by the manufacturer and shall be adjustable for varying degrees of compression via flat shims constructed of 316 Stainless Steel with a shim thickness of 0.5mm. The specified manufacturing tolerance of the hose, when compressed, shall not exceed the occlusion setting of one shim. Rotors incorporating rollers or fixed occlusion shoes are unacceptable.

Pump rotor shall be independently supported on its own set of ball bearings such that the bearings are located directly under the rotor's load. Bearings shall be supported by the bearing hub located within the pump housing and shall be sealed via a dynamic seal constructed of Buna-N. Bearings shall be sealed and greased for life. Pumps which use pump lubricant to lubricate the bearings, external bearing frames which allow overhung loading and require long coupling configurations, or close coupling where the rotor is not supported by pump bearings are not acceptable. Pump bearings shall be replaceable from the front by removing the pump cover plate and shall not require dismantling of the gear box and the motor.

Pump head rotor shall be driven and connected to the gearing via a splined shaft or keyed shaft. Rotor or shaft construction shall be constructed with shear points to allow disengagement from the drive, which shall prevent pump or gearing damage in the event of over torque caused by a locked rotor.

Pump construction shall include a buffer zone between the gearing and pump head to prevent gearbox contamination in the event of a hose lubricant seal failure. The internal pump bearing hub shall be vented through the rear of the pump housing to allow visual detection in the event of a hose lubricant seal failure.

2-2.04. Connectors. Supply pump with flanged inlet and outlet to ASME/ANSI B16.5 Class 150 standards. Flanges and brackets shall be constructed of 316 Stainless Steel and shall be provided with 316 Stainless Steel wetted inserts compatible with the process fluid as indicated in the Operating Requirements.

Pump hose shall extend from the pumping chamber to allow visual confirmation of hose/flange insert connection. Flange insert shall be secured to the pump hose via a single band clamp. Securing the hose using multiple clamps or internal compression fittings that cannot be visually verified as secure without disassembly of the pump or pumps is not acceptable.

Flange supports shall be one piece and constructed of 316 Stainless Steel and shall be secured to the pump housing via four hex head bolts for the 1.5-inch to 4.0-inch pumps and two bolts for 1-inch to 1.25-inch pumps. Flange supports shall maintain a compression seal between the pump housing and hose.

Flexible metal hose connections shall be required for the inlet and outlet connections to the pump. The connections shall be made from corrugated 316 Stainless Steel, with Stainless Steel braiding over the exterior of the corrugations. Each end of the flexible connection shall have a welded 4” inch 150# ANSI Stainless Steel flange. The overall length of the flexible connection from flange face to flange face shall be 16 inches. Where indicated on the drawings, provide grooved end fittings for easier removal of the piping.

2-2.05. Pump Cover. For 1-inch and 1.25-inch pumps, cover shall be constructed of Cast Iron ASTM A48 Class 25 or Carbon Steel ASTM A1011 / A1011M – 10 GR36 and shall be fitted with a fixed window constructed of PMMA. The cover shall be retained to the housing by no more than four hex head bolts and shall be equipped with two hand grips to allow quick and easy removal for replacement of the pressing shoes or shim adjustment.

For 1.5-inch to 4.0-inch pumps, cover shall be constructed of Cast Iron ASTM A245 Class 36 with a removable clear viewing inspection window constructed of PMMA and sufficiently large enough to replace pressing shoes and allow shim adjustment without removing pump cover.

The window shall be sufficiently sized to view direction of rotation of the pump and shall be marked with a minimum lubricant registration mark for proper indication of lubricant level when the pump is stationary.

Pump cover shall be sealed to the pump head via a captive Buna-N quad ring seal.

Pump hardware shall be stainless steel.

Lifting-lugs shall be provided for the front and the back plate of the pump.

2-2.06. Frame. Support frame shall be torsion free and constructed of 304 Stainless Steel. Welded steel or modular adjustable frames are not acceptable. A portable davit crane with hinged supports shall be provided attached to the pump bearing frame. Davit crane shall be capable of lifting the pump cover and swing it out of the way during the pump maintenance. For duplex pumps, one davit crane shall be able to handle either one of the pump covers.

2-2.07. Leak Detector. Provide a float type magnetic reed switch located near the top of the pump to detect leakage of pumped product into the pump housing. Mount the sensor on the rear of the pump housing.

Supply sensor Normally Closed with the ability for field adjustment to Normally Open.

Pump manufacturer to supply switch only. Control panel shall provide terminations for the switch and shall be wired to inhibit the operation of the vector drive and shall provide a fault and lube high level alarm. Contractor shall provide interconnecting conduit and wiring. Contractor is responsible for alarm and relay to turn pump off unless otherwise specified herein.

Float switch shall be rated to the following maxima: Vmax = 240VAC, Imax = 1 Amp, Pmax = 50VAH.

2-2.08. Gearing. For simplex pumps, provide shaft mounted planetary gear box with direct-coupled mounting to the pump housing.

For 4- to 6-inch pumps, provide ultra-compact high-torque planetary gearing with direct coupled mounting face. Gear planetary drive shall be of a modular construction, 1, 2 or 3 stages as required with each module consisting of an internal gear meshing with 3 planetary gears mounted on the planet carrier which shall also engage with the sun pinion. Construct gears and shafts of alloy steel, planet carriers in modular cast iron or steel, and housing of cast iron.

Design gear reduction to match output speed requirement of the pump using two or three-stage gearing and matching torque rating of pumping equipment. Gearing shall

be classified for continuous heavy shock duty, AGMA Class II, 24 hr duty with a minimum of 1.4 service factor.

2-2.09. Pulsation Dampeners. Pump supplier shall provide and install pulsation dampeners in the suction and discharge line of each pump as shown on the drawings.

Dampener shall be chargeable, appendage type, consist of a two-part housing and bell shaped flexible bladder, designed for vertical tee mounting in the suction or discharge line, and shall be BLACOH Fluid Control Model CT5440Nor equal. The bladder shall be charged on the pressure side by means of a tire valve connection fitted with a pressure gauge capable of reading the maximum charge pressure of the unit, but with sufficient resolution to enable lower charge pressures to be readily indicated. The two (2) chambers of the dampener shall be bolted together to facilitate the replacement of the Neoprene bladder. The pulsations dampeners shall be flanged to the pump inlet by means of an ANSI 4" 150 psi raised face flange.

Dampener shall include one-way air inlet valve to prevent product backflow, pressure gauge, and air fill valve. Dampener housing shall be all carbon steel rated to 300 psi working pressure. Bladders shall be Neoprene.

Contractor shall provide an appropriate tee for mating to pulsation dampener and piping. Contractor shall install pulsation dampeners in accordance with the manufacturer's instructions and air-charge the dampener in accordance with the process requirements as recommended by the manufacturer. Pulsation dampener shall be mounted within three feet of the pump discharge port but with adequate space provided for hose changes. No other equipment shall be installed between the discharge pulsation dampener and pump.

2-2.10. Pressure Isolator Ring, Gauge, and Switch Assembly. A wafer style pressure isolator ring shall be required for fitting between DIP flanges on the outlet of the pump. The isolator shall incorporate a pressure gauge and pressure switch, the complete unit being silicon liquid filled. The pressure switch shall be capable of being adjusted, without removal of the cover, over the range of 3-150 psi. Enclosure for the pressure switch will be NEMA 4X. The pressure gauge shall be 4 ½ inch diameter and shall have a stainless steel case, Bourdon tube and socket. Range shall be 0-160 psi. Gauge shall be liquid filled with Silicon fluid. Complete assembly shall be Onyx Valve or equal.

2-2.11. Motors. Electric motors shall conform to the requirements provided in the Common Motor Requirements for Process Equipment section.

2-2.12. Adjustable Frequency Drives. Adjustable frequency drives shall conform to the requirements of Section 16150.

2-2.13. Shop Coatings. Coatings shall comply with the requirements of Section 09900. At minimum, provide pump assembly primed and finish painted as follows:

1. Primer Coat
   a. Two pack (component) epoxy resin primer
   b. Dry thickness 20-40 micron
2. Finish Coat
   a. Two pack (component) acrylate isocyanate combination
   b. Dry thickness 20-40 micron
   c. Manufacturer shall supply two (2) quarts of the finish coat for touch-up purposes by the installer.
   d. Color shall be as determined by the Owner during the submittal review process.

2-2.14. Accessories. The pump supplier shall provide all the required components as listed below:

Onyx annular ring pressure gauge isolators, flanges, Teflon gaskets and 316 SS bolts, nuts, and washers required for installation.
Annular ring isolators shall be liquid filled and factory fitted with suction pressure gauges and discharge pressure gauges and pressure switches as required and noted elsewhere.

Suction and discharge pressure pulsation dampeners as recommended by the pump manufacturers and pressurized to the recommended air side pressure.

Isolation and flushing valves shall be provided by the purchaser and installed by their contractor.

Pumps shall be supplied with integral lifting arms to support the cover plate and permit it to be moved clear of the hose chamber.

2-2.15. Revolution Sensor. Provide inductive type sensor to detect rotor revolutions. Mount sensor on the rear of the pump housing. Pump manufacturer to supply sensor and DC relay and any terminations in their control panel for integration into the purchasers' DCS system. Contractor is responsible for any additional equipment which may be required to integrate this into the control system.

Inductive sensor actuates a non-maintained NO switch when triggering device passes the sensor. When inductive sensor is powered and pump is in operation a pulse waveform is generated.
Inductive sensor shall be rated to the following maxima: Vmax = 30VDC, Imax = 150 mA, Pmax = 4.5VA

2-2.06. Local Control Panels. Local control panels adjustable frequency drive enclosure shall be provided in accordance with Division 16 and Division 17500. Pump manufacturer shall provide the necessary information and data to the control panel integrator as required by the panel integrator.

2-3. SPARE PARTS

2-3.01. The following spare parts shall be provided for each pump:

1. Sixteen replacement hoses for each size of pump being provided.
2. Sixteen hose lubricant refills for the entire volume of lubricant required for the size of pump being provided.
3. Sixteen sets of replacement gaskets and seals for each size of pump provided.

2-4. SHOP TESTING

2-4.01. General. Each pump shall be subjected to a complete shop test. Certified test reports, in triplicate, shall be submitted to the Engineer. No equipment shall be shipped until receipt of the Engineer's written approval. Costs for the shop tests shall be in the bid price.

2-4.02. Pumps shall be hydrostatically tested with a test pressure of 150 percent of the maximum possible working pressure at design speed.

2-4.03. Pumps. Each pump shall be shop tested to determine the following characteristics:

1. Head-Capacity Curve including speeds required through full range of flow conditions, taking specific gravity into consideration.
2. Brake Horsepower Curve
3. Efficiency Curve
4. Aptitude of vibrations throughout pump operating range
5. NPSH required at the maximum design flow and TDH

2-4.04. Shop testing shall also include the following steps:

1. Non-witnesses Inlet Vacuum Testing.
2. Test assembled Pump running on air.
3. Run test for a minimum of 30 seconds and record vacuum reading which must meet or exceed 28” Hg vacuum.
4. In the event that specified tests indicate that the pump does not meet specifications, Engineer has the right to require complete tests for the pump at no additional cost to the owner.
5. Repeat tests until specified results are obtained.
6. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

2-5. PRODUCT DATA

2-5.01. The following information shall be provided in accordance with the General Conditions:

1. Operating and maintenance information as specified in Section 01800 and Section 01730. Provide required preventative and periodic maintenance requirements and required documentation to be maintained for the warranty.
2. Electric motor manufacturer's standard overhaul instruction for motors.
3. A certificate confirming the compatibility between the pump motors and the AFD.
4. Certified factory test data confirming the specification requirements.

PART 3 – EXECUTION

3-1. INSTALLATION

3-1.01. The pumps shall be installed as specified and in accordance with manufacturer's written recommendations. Contractor shall install pumping equipment on a concrete pad and make final alignments thereon. Contractor shall ensure the pumps' suction and discharge port connections to process lines are non-leaking and made in a free supported state without need to apply vertical or horizontal pressure to align piping with pump nozzles.

3-2. FIELD TESTING

3-2.01. Testing shall be performed by the Contractor with assistance of Manufacturer's Field Service Technician.

3-2.02. After installation of pumping equipment, and after inspection, operation, testing, and adjustment have been completed by the Contractor in the presence of the Manufacturer's Field Service Technician, Contractor shall conduct running test for each pump in the presence of the Engineer to determine its ability to operate within the performance limits specified and to deliver its rated capacity within the pressure requirements specified. Contractor shall provide labor, piping, equipment, and materials necessary for conducting all field tests.

3-2.03. Contractor shall make all adjustments necessary to place equipment in specified and working order at the time of above tests. Test pumps on product only. Promptly correct or replace all defective equipment revealed by or noted during tests at no additional cost to the Owner and repeat tests until specified results acceptable to Engineer are obtained.

3-3. TRAINING

3-3.01. A minimum of 16 hours of training conforming to the requirements of Section 01664 and the following shall be provided. Training shall be certified as specified in Section 01664. Training shall include instruction on field adjustment of rotor clearances and shall include complete disassembly and subsequent reassembly of one pump.

End of Section

Section 11410

CIRCULAR CLARIFIER EQUIPMENT

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing circular clarifying equipment.

Number of units.

Sludge collectors.	3 (2 in Base Bid and 1 as an Additive Alternative)

Equipment tag numbers.

Sludge collectors.	PCLR-20, PCLR-30, PCLR-40 (Additive Alternate)

Clarifier mechanisms shall be of the center drive type, supported on a stationary influent column with the flow entering at the bottom of the influent column and flowing upward into a center feedwell. The clarifiers shall be designed to remove settled sludge from the bottom of the tank.

Each clarifying mechanism shall be as specified herein and shall be designed for installation in a circular basin having the dimensions indicated on the Drawings.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Equipment shall be furnished complete with all mechanical and electrical components and accessories required for proper operation, including complete drive units and controls; and any additional materials or construction required by the manufacturer's design.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Power Supply. Power supply to the equipment will be 480 volts, 60 Hz, 3 phase.

1-2.03. Identification. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-2.04. Piping and Valves. The threads for oil fill and drain piping and fittings shall be NPT standard. Sludge piping is covered in the ductile iron pipe section. Miscellaneous piping and miscellaneous valves are covered in the piping and valve sections, respectively.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, together with detailed specifications and data covering materials, power drive assemblies, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Drawings shall indicate all dimensions and structural member sizes, and shall be certified by an officer of the company manufacturing the equipment that the design is in compliance with all local laws and codes for the Project location.

Data and specifications for each unit shall include, but shall not be limited to, the following:

Torque rating.
Arm tip speed.
Shop painting.
Structural drawings.
Electric motor data in accordance with the submittal requirements of the Common Motor Requirements for Process Equipment section.
Electrical control equipment.
Type, specifications, AGMA rating, details, input and output speeds, exact gear ratios, and service factor (24 hour continuous service) of gear reducers.
Description of overload device.
Wiring diagram and electrical schematic.
Bearing type, size, and manufacturer.
Gearbox type, size, manufacturer, torque ratings, input Hp, duty classification, shaft diameter, coupling information, service factors, and mounting bracket information.
Size, make, type, and details of weir actuator for scum skimming equipment, when weir actuator is required.
Certification of the AGMA drive rating calculations by a registered professional engineer.
Certification of the bearing life calculations by a registered professional engineer.
Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. SPARE PARTS AND ACCESSORIES. The following spare parts and accessories shall be furnished for each drive unit furnished. The spare parts shall be furnished in substantial wooden boxes with identifying labels and delivered to the Owner as directed.

Spare Part	Quantity
Bearings and seals	One per basin

PART 2 - PRODUCTS

The new clarifiers shall be used for primary clarification of screened and degritted municipal wastewater.

2-1. SERVICE CONDITIONS. Service conditions shall be as required.

Type of wastewater treatment.	Primary Clarification
Temperature range	55°F to 85°F
Chemicals to be added	Ferric chloride, Polymer
Water quality data, annual average concentrations	cBOD 147 mg/L TSS 158 mg/L
Water quality data, max month average concentrations	cBOD 148 mg/L TSS 152 mg/L
Performance	65% TSS removal 80% TSS removal with $FeCl_3$ addition 21% BOD removal 26% BOD removal with $FeCl_3$
Equipment exposed to temperatures that could produce icing	No

2-2. STRUCTURAL DESIGN. Unless indicated otherwise, all structural members, plates, or shapes shall be a minimum of 1/4 inch thickness. The ratio of unbraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (for angles about the Z-Z axis).

For simple spans, deflection shall be less than or equal to L/360 for the total load. For cantilever spans, deflection shall be less than or equal to L/240 for total load.

Design criteria for calculating wind, snow, and seismic loads shall be as indicated in the Seismic and Meteorological Design Criteria section.

The collector arm trusses shall be designed to withstand the specified minimum rated torque.

In addition to the specified torque, structural members and connections shall be designed to withstand a non-operating vertical live load of 500 lbs at the outer end of either truss arm. The 500 lbs load is for structural design only, and is not a condition which must be met during operation.

In addition, all structural members and connections shall be designed so that the unit stresses will be less than 90 percent AISC yield stresses when subject to loading of two times the maximum calculated running torque. The preceding deflection criteria does not have to be satisfied at loading of two times the maximum calculated running torque. Walkway and feedwell baffle support beams shall not be submerged.

Equipment design shall provide sufficient strength and rigidity such that while sweeping floor grout, no member will be loaded to a level beyond the maximum allowed by current AISC standards
The design of the equipment shall consider surface preparation and painting requirements and shall comply with the recommendations of the SSPC. Inaccessible welds and welding of angles back-to-back shall be avoided.

Submerged carbon steel or stainless steel components shall not be fabricated from sections with a hollow cross-section, such as pipe or tubular sections; only bars, plates, angles, channels, and other rolled sections shall be used.

2-3. PERFORMANCE AND DESIGN REQUIREMENTS. Clarifying equipment shall perform the following integrated functions:

a. Dissipate inlet energy and prevent localized currents.
b. Separate settleable solids from the effluent.
c. Evenly withdraw the clarified effluent.
d. Transport and thicken settled solids.
e. Prevent dilution of the settled solids at the withdrawal point.
f. Remove scum from the liquid surface in the basin.

2-3.01. Basin Dimensions and Features. The equipment shall be designed to operate in basins having the following dimensions and features:

Shape of basin	Circular	

Basin inside diameter	130	ft
Basin floor radial slope to center	1 to 12	
Total sidewall depth	16.31	ft
Sidewall water depth at peak flow	14	ft
Diameter of influent pipe	54	in

2-3.02. Design Requirements. The equipment design requirements shall be as follows:

Annual average design flow per basin.		8.44	mgd
Maximum month flow per basin.		11.74	mgd
Peak flow per basin.		17.54	mgd
Minimum rate of sludge removal per basin.		5.06	mgd
Average rate of sludge removal per basin.		5.06	mgd
Maximum rate of sludge removal per basin.		10.5	mgd
Center column.			
	Center pier minimum diameter.	60	in
	Number of ports in center column.	4	
	Width of ports in center column.	18	in
	Water depth in ports in center column.	30	in
	Total port depth.	33	in
	Maximum total headloss through the entire center column and out of the energy dissipating inlet ports into the feedwell at peak flow.	14	in
Collector equipment			
	Collector drive type.	Constant speed	
	Collector approximate tip speed.	11.5	fpm
	Collector drive minimum rated torque.	34	ft-kips
	Collector drive unit minimum ball race diameter.	45	in
	Bearing type.	Strip liner bearing or Four point	

		contact bearing	
	Balanced dual pinion drive required.	No	
	Secondary collector arms required.	Yes	
	Secondary collector arm length.	32.5	Ft
Energy dissipation inlet (EDI).			
	Minimum diameter.	10	Ft
	Depth below water surface.	3	Ft
	Number of ports.	6	
	Width of ports.	16	in
	Water depth in ports.	26	in
	Total port depth in EDI.	29	in
Hydraulic flocculation feedwell.			
	Minimum diameter.	32	Ft
	Depth extended below water surface.	5	Ft
	Total feedwell depth.	5.5	Ft

The torque cage, and drive mechanism shall be designed to withstand the specified minimum rated torque.

The rated torque of all components of the collector drive unit shall equal or exceed the torque equivalent to the nameplate horsepower of the drive motors.

The torque shall be measured from the center line of the equipment. Loading to develop the torque shall be considered as uniform loads applied simultaneously on both arms.

2-3.03. Noise Level. All motor driven components shall be designed and constructed so that the maximum noise level measured at 3 feet from the installed equipment drives and motors does not exceed 80 dBA.

2-4. ACCEPTABLE MANUFACTURERS. Sludge collecting equipment shall be Ovivo/Eimco Water Technologies or WesTech. No other manufacturers will be considered.

2-5. BOLTS AND NUTS. The bolts, nuts, and washers shall be suitable for field assembly, and be provided for each item of equipment.

All field assembly bolts, nuts, and washers in submerged locations shall be stainless steel. Field assembly bolts, nuts, and washers in other locations shall be hot-dip galvanized. A washer shall be installed under each nut.

Assembly Bolts and Nuts.

Carbon Steel	ASTM A307 or ASTM A36.
Stainless Steel	Bolts ASTM F593, Alloy Group 2; Nuts ASTM F594, Alloy Group 2.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM F2329.
Flat Washers	ANSI B18.22.1; of the same material as the bolts and nuts.

Anchor bolts shall comply with Figure 1-11410 and the Anchorage in Concrete and Masonry section.

Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2-6. CONSTRUCTION.

2-6.01. Fabrication. The materials of construction for the bridge support structure, equipment platform, and all collector components in contact with liquid, including scum skimmer components, shall be 316L stainless steel. Welded joints shall be sealed watertight with continuous welds. Fillets and corners must be accessible for grinding. Bolts that are provided at connections to facilitate field weld joints shall be removed and the holes shall be plug welded before painting. Faying surfaces of bolted joints shall be shop coated.

2-6.02. Edge Grinding. All cut or sheared edges shall be ground smooth to a 1/8 inch minimum radius for all material 1/4 inch thickness and larger. For material thickness less than 1/4 inch all cut or sheared edges shall be ground smooth to a radius equal to 1/2 the material thickness. Grinding of rolled edges on standard shapes with a minimum radius of 1/16 inch will not be required.

2-6.03. Surface Preparation. In preparation for painting, all ferrous metal surfaces shall have all welds ground smooth and free of all defects in accordance with NACE Standard RPO178, Appendix C, Designation C and sharp edges ground smooth, if not previously prepared in the shop. Instead of blending of the weld with the base metal as specified by the NACE standard, it will be acceptable to furnish a welded joint that has a smooth transition of the weld to the base metal. All welds shall be ground smooth to ensure satisfactory paint adhesion.

2-6.04. Shop Coating. Iron and steel surfaces of the equipment that will be in immersion service shall be cleaned to SSPC-SP10 and primed with manufacturer's standard shop coating which will be removed prior to field coating. All other iron and steel surfaces of the equipment shall be cleaned to SSPC-SP10 and prepared as recommended by the coating manufacturer for the intended service, and then shop coated with one or more coats of a universal epoxy primer. The General Equipment Stipulations include further shop coating requirements.

2-6.05. Stainless Steel. All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces contaminated or damaged during fabrication including welded areas shall be repickled or passivated in accordance with ASTM A380 as needed to remove all traces of iron contamination and heat tint. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2-6.06 Field Painting. Iron and metal surfaces of the equipment that will be in immersion service shall have the shop coating removed prior to field painting and the surfaces field painted as specified in Protective Coatings section. The center drive equipment, electric motors, speed reducers, and other drive components shall be completely protected during blasting operations. Also, equipment components that are shop primed and top coating in the field shall be painted as specified in the Protective Coating section.

All non-submerged stainless steel components and all stainless steel components installed within 3 inches below the minimum water surface elevation shall be field painted with epoxy enamel. Preparation and painting of the stainless steel components shall be as specified in the Protective Coatings section.

2-6.07. Drive Units. Drive units shall be selected, designed, and rated in accordance with AGMA standards and the criteria specified herein. Where AGMA standards and the criteria specified herein are in conflict, the values that will result in the most conservative design for long life and minimum maintenance shall be selected.

Each drive unit shall be constant speed as specified herein, and shall be anchored to the turntable base. Each drive unit shall be directly connected to a speed reducer and drive motor. Drive units with a pinion mounted directly on the motor shaft will not be acceptable.

The sludge collection drive unit motor shall be in accordance with the Common Motor Requirements for Process Equipment section, except that sealed bearings may be provided if they have an ABMA L_{10} rating of at least 100,000 hours.

2-6.07.01. Overload Mechanism. The drive of the rotating scraper assemblies shall be equipped with an indicating torque overload mechanism with a NEMA 4X, cast iron, stainless steel housing, or baked epoxy-coated cast aluminum housing and two independently adjustable, switches. The torque overload mechanism shall be attached to the primary hydraulic reduction unit, and activated by the hydraulic pressure in the primary reduction unit. The torque load of the drive shall be indicated on a stainless steel 6-in diameter torque gauge in ft-lbs.

The overload mechanism shall be factory adjusted. The "Alarm" switch shall energize the alarm circuit when the load reaches approximately 100 percent of the rated torque of the drive unit. The "Stop" switch shall energize the motor cutoff circuit to stop the motor at approximately 120 percent of rated torque. The overload mechanism shall be adjusted and set at the factory.

A hydraulic pressure relief valve shall be provided as additional overload protection to prevent 150 percent of the rated torque from being applied to the drive mechanism. A third independently adjustable, electrically operated contact will not be acceptable as a substitute for additional overload protection.

The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hours continuous service.

2-6.07.02. Gearmotors. The use of gearmotors sharing an integral housing or that cut gears into the motor output shaft, or that require removal of lubricant from the gear reducer to change the motor will not be acceptable.

2-6.07.03. Gear Reducers.

The equipment drive shall use a hydraulic drive motor to transfer power from the electric motor to the intermediate gear reducer (by DBS, no substitutes). The hydraulic reducer shall be the first (primary) speed reduction and features a hydraulic gear pump and motor designed for low-speed, high torque operation. All components shall be enclosed in 7 gallon minimum stainless steel hydraulic reservoir. The hydraulic drive shall perform exactly like an electro-mechanical drive with a specific speed reduction ratio.

The primary gear reduction shall be a motor driven hydraulic gear pump with a 3.0 service factor. The hydraulic drive shall incorporate a pressure relief valve as back up against overload, a flow control valve, a reversing valve port, a 4-20 mA transducer port, a pressure gauge port, and a hydraulic filter port, which shall be enclosed in the reservoir to help prevent tampering. A 6" gauge with torque measured in ft-lb shall be provided and readable from the walkway. An externally accessible disposable "spin-on" type filter shall be provided to filter the hydraulic oil before it enters the hydraulic pump. Exposed hydraulic oil piping or hoses shall not be permitted.

The intermediate gear reduction unit shall be mounted on top of the final reduction unit and properly registered to maintain accurate centers for the final gearing. It shall have sufficient bearing capacity to fully support the pinion gear without a lower support bearing. The L10 life of the intermediate reduction unit bearings shall be in excess of 100,000 hours at continuous torque rating of the drive unit.

The final reduction unit housing shall be manufactured from A36 steel plate. All welds shall conform to applicable specifications of the ASME. After welding, all mounting and mating surfaces shall be machined to insure proper fit and alignment of the drive pinion and mating gear. The base plate on which the gear and bearing is mounted shall be flat within 0.005 inch. The steel plate to which the intermediate pinion drive gearbox is mounted shall be a minimum of 1.5 inch thick. The final reduction unit gear shall be machined to AGMA grade 6 or higher. Gear teeth shall have a core hardness of 250 to 300 BHN, and be induction hardened to 55 RC. The final reduction unit pinion shall be made of heat-treated alloy steel and shall be mounted on the output shaft of the intermediate reduction gearbox. The pinion teeth shall be induction hardened to 55 to 60 Rc. The bearing shall have a seal to prevent contamination of the bearing raceway. The bearing shall have a L10 life in excess of 100 years.

The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F.

Each oil lubricated bearing shall be installed in a bearing housing designed to facilitate periodic re-oiling of the bearing by means of a manually operated oil gun. Each bearing housing shall be designed to evenly distribute new oil, to properly dispose of old oil, and to prevent over-oiling of the bearing. At the manufacturer's option, permanently sealed, oil lubricated bearings meeting the specified ABMA L_{10} bearing life of 200,000 hours may be provided. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings. A dipstick or a sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.

Gear reducers which require the removal of parts or the periodic disassembly of the unit for cleaning and manual re-oiling of bearings will not be acceptable.

Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.

2-6-07.04. Adjustable Speed Drive. Not used.

2-6.08. Lubrication. Gear reducer gears and bearings shall be oil lubricated. Gears and lubricated bearings shall run in oil or shall be provided with a positive means of continuous lubrication. Seals shall be provided around shafts to prevent leakage of oil.

Splash lubrication is not acceptable. Due to potential low speed gear rotation, a positive means of lubrication shall be provided.

Lubrication systems shall be so designed that they are protected against contamination and the lubricants cannot contaminate the water being treated. Each lubrication system shall be provided with an external, visual method of checking lubricant level, without removing parts or fittings. A dipstick or sightglass arranged to permit visual inspection of the lubricant level shall be provided on each unit.

Lubrication shall be accomplished by means of convenient and readily accessible oil fill and drain plugs or oil fittings that do not require the removal of parts or dismantling of equipment. Oil drain and fill openings shall be easily accessible from the operating platform, convenient for collection of oil in 18 inch high containers from the platform, without removing the unit or equipment platform from its normal installed position.

Alternately, systems that allow oil to be easily drained and filled from the equipment platform which utilize a portable pump to remove the oil to containers on the equipment platform may be used if acceptable to Engineer.

2-6.09. Equipment Bases. Cast iron or welded steel baseplates shall be provided for the equipment.

2-7. CENTER SUPPORT.

2-7.01. Central Feed Radial Flow Units. Each mechanism shall be supported on a cylindrical steel center pier/influent diffuser, through which influent flow enters the basin. The center pier shall be of sufficient height to accommodate level installation of the access walkway and to support the turntable above the specified maximum water level.

The center pier shall support all loads from the rotating mechanism, including torque and the equipment platform, access walkway, and influent well baffle wall. The minimum diameter of the center pier shall be as specified herein, and the shell thickness shall be at least 1/2 inch for diameters 48 inch or less, and not less than 3/8 inch thick for larger than 48 inch diameter. The cross sectional area of the center pier influent ports shall be as large as practicable without compromising the structural integrity of the center pier. Influent ports and other openings shall be suitably reinforced.

The anchor bolt connection between the center pier and the concrete structure shall be designed to resist all loadings, including the maximum torque that may be applied by the drive mechanism. The center pier shall be plumbed and leveled using removable shims and wedges. The use of leveling nuts on the anchor bolts will not be permitted.

A watertight connection shall be provided between the center pier and the bottom of the basin. All details of the connection shall be indicated on the submittal drawings.

A 3 inch flanged outlet shall be provided on the center pier just above the bottom baseplate for draining the center column. A blind flange and bolts, nuts, and washers shall be provided for the flanged outlet. The flanged outlet shall project a minimal distance from the pier wall.

2-7.02. Feedwell Baffle Wall. A feedwell zone in the center of each basin shall be separated from the settling zone by a cylindrical baffle wall. The baffle shall be supported from the walkway and support beams or trusses and shall be fabricated from suitably reinforced plate at least 3/16 inch thick. The baffle wall and supports shall be designed to withstand a horizontal wind load on the projected area when the basin is dewatered. Wind load design criteria shall be as indicated in the Seismic and Meteorological Design Criteria section. The baffle wall shall be supported from the walkway and support beams or trusses.

Spaced openings shall be provided in the baffle wall to release scum to the settling zone. Each scum outlet shall be provided with a slotted plate baffle which can be adjusted vertically to optimize scum removal.

2-7.02. Energy Dissipating Inlet (EDI). A rotating circular energy dissipating inlet with bottom shall be supported by the cage and be designed to diffuse the liquid into feedwell in a tangential direction. The EDI shall be designed to positively prevent sludge from depositing within the EDI and shall include bottom drain holes. The rotating EDI shall be designed with a full bottom extending to within 1 inch of the center column.

The gap between the center pier and EDI shall be bridged with a neoprene seal. It shall include an upper rim angle for stiffness. Multiple tangential diffuser gates shall be provided to induce a tangential flow velocity between the EDI and feedwell and specifically preclude any vertical currents. The vertical wall of the gates shall be curved at a constant radius and shall not restrict the flow. The tangential baffle shall extend past the gate openings at least the same distance as the opening width. The gates shall have a fixed bottom to prevent vertical currents as the flow exits the EDI.

The hydraulic flocculating zone in the center of each basin shall be separated from the settling zone by a cylindrical baffle wall. The baffle wall shall be supported from the walkway and support beams or trusses. Baffles shall be fabricated of suitably reinforced plate not less than 3/16 inch thick. The baffle wall and its supports shall be designed to withstand a horizontal load of 30 psf [1.5 kPa] on the projected area when the basin is dewatered.

An influent well energy dissipating device which will diffuse the influent into the basin with minimum turbulence shall be provided on each unit. The energy dissipating device may be supported from the center cage or the walkway support beams and trusses.

A flocculating zone in the center of each basin shall be separated from the settling zone by a cylindrical baffle wall. The baffle shall be fabricated from suitably reinforced plate at least 3/16 inch thick. The baffle wall and supports shall be designed to withstand a horizontal wind load on the projected area when the basin is dewatered. Wind load design criteria shall be as indicated in the Seismic and Meteorological Design Criteria section. The baffle wall shall be supported from the walkway and support beams or trusses.

Spaced openings shall be provided in the baffle wall to release scum to the settling zone. Each scum outlet shall be provided with a slotted plate baffle which can be adjusted vertically to optimize scum removal.

2-8. CENTER MECHANISM. The center mechanism shall consist of the drive unit, gearing, and the supporting structure for the sludge collecting equipment.

2-8.01. Sludge Collection Turntable Assembly. The sludge collecting equipment shall be driven by a turntable assembly that consists of a large diameter main bearing and a drive unit. The main bearing shall consist of annular bearing raceways near the outer circumference which shall rotate on alloy steel balls and shall be a strip liner bearing or four point contact bearing as specified herein. Main bearings shall have an ABMA L_{10} life rating of at least 200,000 hours and shall be designed to carry all vertical loads and torque loads plus an additional allowance of 25 percent of the weight of the rotating equipment. A ring gear shall be provided on the turntable. Ring gears shall be cast integrally with the turntable or bolted in place.

The turntable and ring gear shall be cast iron or ductile iron. Ring gears shall be rated according to AGMA Standard 2001-C95 or the current standard for operation at the required continuous torque rating for a minimum life of 200,000 hours. The valved oil bath drain shall be easily accessible from the center platform. The drain shall terminate in a turned down elbow and shall be suitable to support a container to receive waste oil.

2-8.01.01. Strip Liner Bearing Ball Races. Strip liner turntables shall rotate on alloy steel balls. Ball races for each main bearing shall be hardened to at least Rockwell C60 or provided with renewable hard steel liner strips. The balls shall run in an oil bath and shall be protected by a synthetic flexible seal and dust shield. A cast iron, ductile iron, or steel ring gear shall be provided on each turntable. Ring gears shall be cast integrally with the turntable or bolted in place.

2-8.01.02. Four Point Contact Lock Race Bearings. Turntables with four point contact lock race bearings shall rotate on chrome steel ABMA Grade 48 balls. The ball race shall be four point contact, precision ground raceway, induction hardened to at least Rockwell 55. The balls shall run in an oil bath and shall be protected by a synthetic flexible seal and dust shield. A ring gear heat treated to at least Rockwell 30 shall be provided on each turntable and shall be bolted in place.

2-8.02. Rotating Scraper Assemblies. The center mechanism shall be equipped with two (2) full radius and two (2) half radius rotating scraper arms attached to and supported from a center cage. The center cage shall be reinforced top and bottom for proper distribution of loads to supports, and shall have adequate strength and rigidity to support and rotate the scraper arms under maximum load, with an adequate factor of safety. Scraper arms shall be fabricated from structural steel members using triangular or box truss construction, especially designed to accommodate corner sweeps when they are required. Longitudinal members of the triangular trusses shall be fabricated from bent plates at least 1/4 inch thick and a minimum leg width of 2 inches. Longitudinal members of box trusses shall be fabricated of steel at least 1/4 inch thick and a minimum leg width of 2 inches. Trussed arms shall be designed without tie rods.

The scraper arms shall conform to the slope of the basin bottom. The clearance between the basin bottom and the blades shall not exceed 1-1/2 inches at any point.

The rotating arms shall be equipped with blades of the spiral type to move settled sludge to the collection point. Each arm shall collect sludge over the full area of the basin bottom. The height of each spiral blade shall be 12 in at the basin periphery, shall be 38 in at the basin center, and shall have a constant taper over the length of the blade. Each blade shall have adjustable stainless steel squeegees at the bottom edge. Squeegees shall be fastened to rake blades with stainless steel fasteners.

2-8.03. Corner Sweeps. Not used.

2-8.04. Scum Skimmers - Type 1. The basin shall be equipped with baffles and devices that collect floating scum and flush it into a trough for removal. Skimming equipment shall be designed to operate with the circumferential scum baffle indicated on the Drawings and shall consist of skimmer and wiper assembly, scum trough with approach ramp, and discharge pipe.

The basin shall be equipped with two skimming arms. Each skimmer shall collect scum the full distance between the influent well or feedwell and the scum baffle. The skimming arm shall form an angle of at least 2 degrees with the center line of the rake arm, and the entire weight of the arm shall be supported by the rotating machine. Designs which rely on the scum baffle for support will not be acceptable.

The wiper blade shall be at least 6 inches wide, extending approximately 3 inches above and 3 inches below the water level. The wiper shall have adjustable neoprene edges and shall rake scum up the approach ramp of the scum trough and automatically discharge it into the trough. The wiper assembly shall be supported at the outer end in its travel over the scum trough. The approach ramp shall be long enough for efficient removal of scum and shall extend at least 12 inches below the top of the V-notch weir. The ramp crest shall be at least 1 inch above the top of the weir. The scum baffle, which normally projects 2 inches above the top of the weir as indicated on the Drawings, shall be extended to 8 inches above the top of the weir at the scum ramp and

at least 12 inches beyond each end of the ramp. In addition, the depth of the scum baffle shall be increased by 10 inches from 12 feet ahead of the leading edge of the ramp to 8 feet beyond the trailing edge of the ramp.

The scum trough shall be provided with a cam operated valve which shall flush the trough with basin water at each pass of the skimmer. The operation of the valve shall satisfactorily flush the scum trough. Valve opening and duration of flushing shall be adjustable.

The size and arrangement of the discharge pipe from the scum trough shall be as indicated on the Drawings.

2-8.05. Scum Skimmers - Type 2. Not used.

2-9. ACCESS WALKWAY. Each clarifier shall include beams and trusses supported on the basin wall and spanning to the center column and shall be provided to support the basin walkway.

The turntable top shall have a platform above the center column for convenient access to the center drive mechanism. The platform shall be wide enough to provide a clear space of at least 2 feet on all sides of the equipment. The platform shall be accessed from the basin wall by the access walkway which shall extend from the basin wall to the platform. The equipment platform shall have the same floor elevation as the access walkway and shall be floored with 1/4 inch aluminum checkered plate.

The access walkway shall be at least 36 inches wide. A clearance of 30 inches shall be maintained on the basin walkway at the weir actuator, and the walkway shall be widened sufficiently to allow a clear space of at least 2 feet on three sides of the weir actuator. The walkway shall be floored with 1/4 inch aluminum checkered plate, and shall be diagonally braced against lateral movement. A kickplate at least 4 inches high shall be provided around the entire walkway, including the equipment platform. The walkway shall be so designed and constructed such that deflection will not exceed 1/360 of the span length considering all dead loads plus a live load of 50 lbs per square foot and a horizontal load of 30 lbs per square foot against exposed walkway surfaces. Slide plates shall be provided at the wall supports. Walkways of the underhung truss type are not acceptable.
Grating and checkered plate shall be fabricated and attached to the structure in accordance with the Grating and the Structural and Miscellaneous Metals sections.

A stair with treads matching the walkway floor shall be provided at the basin wall end of each walkway. Materials of construction shall match the walkway.

Railing system shall conform with local code requirements for public use, as required.

Three-rail railings 3'-6" high shall be provided along each side of each beam-supported walkway and stair, and around the equipment platform. Railings shall be aluminum as

specified in the Handrailing, Guardrailing, and Ladders section. Walkway trusses may serve as railings, provided the top chord is 3'-6" above the walkway surface and the space between members does not exceed 4 inches for public use, and 12 inches for nonpublic use. Otherwise, railings shall be mounted on each side, 3'-6" above the surface. A rectangular aluminum mounting plate for electrical equipment shall be provided on the equipment platform railing and near the rotating weir actuator when it is included. The bolts and hardware used to install the mounting plates shall be stainless steel.

Contractor shall provide lighting fixtures and poles at the locations indicated on the electrical Drawings, and shall coordinate the locations with the clarifier equipment manufacturer. The necessary lighting support system shall be provided on the clarifier walkway.

Walkways shall be provided with the necessary brackets for supporting the electrical conduits and chemical lines indicated on the Drawings.

Flush-mounted, hinged covers shall be provided in the walkway floors for access to vent valves in chemical lines and for access to chemical feed points.

2-11. CONTROL EQUIPMENT. Control devices not required to be mounted on the basin equipment shall be installed on the aluminum mounting plates attached to the handrails using stainless steel bolts and fasteners.

2-11.01. Sludge Collector Control Equipment. Control equipment for each sludge collector shall include a thermal-magnetic circuit breaker type combination NEMA size 1 motor starter, three externally reset thermal overloads, a 120 volt control power transformer, an "Off-On" maintained selector switch, an amber motor overload indicating light, a latch relay for torque overload with an external reset push button, alarm relays, and a vaportight alarm lamp with 3/4 inch bottom hub, red globe, guard, and 60 watt bulb. The control power transformer shall have one secondary lead fused, the other grounded, and capacity for all simultaneous controls and alarms. The controls shall be mounted in a stainless steel NEMA Type 4X enclosure with a 3/4 inch top hub for the alarm lamp.

Sludge collector equipment shall be locally alarmed.

For locally alarmed systems, the enclosure mounted near the collector drive shall include a alarm horn with an alarm silence relay and push button. The horn shall be 120 volts ac, NEMA 4X, with volume adjustment. The horn and the alarm light shall sound and be illuminated on high torque and shutdown on torque or motor overload alarm.

Push buttons, selector switches, and indicating lights shall be heavy-duty and weatherproof.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with the Equipment Installation section and as specified herein.

Weir plates shall be adjusted to a level position after installation to provide uniform overflow rate at all points. The blades on each scraper shall be adjusted to the contour of the basin floor. All stainless steel bolts shall be tightened with a torque wrench. Torque values for all stainless steel bolts shall be in accordance with the manufacturer's recommendations. The recommended values shall prevent undershearing and/or seizing of stainless steel bolts.

To ensure that each sludge collecting mechanism is functioning properly, it shall be run at least 4 hours before flow is admitted to the basin.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Construction Manager.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily. All costs for these services shall be included in the Contract Price for the number of days and round trips to the site as required for compliance.

3-2.03. Field Load Test. Contractor shall perform a load test on the sludge collection equipment in accordance with the recommendation of the equipment manufacturer. The mechanism shall be loaded until there is sufficient torque created on the drive to trip the alarm unit at 100 percent of the rated torque and continue loading until the "Stop" contact is activated at 120 percent of the rated torque of the drive unit. The equipment manufacturer shall provide Contractor with detailed instructions on where and how to connect the loads to the arms and shall have a service representative present during the test.

3-3. EXTENDED WARRANTY. Not used.

End of Section

Section 11520

VERTICAL MIXERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of vertical, shaft-driven rapid mixers and vertical, shaft-driven flocculator mixers as specified herein. The units shall be furnished and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in this Section or not, and as required for an installation incorporating the highest standards for the type of service specified.

Mixer Designation.	SRWRC Clarifier Influent Junction Box
Number of Mixers.	2
Mixer tag numbers.	MXP-10, MXP-30

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Each unit shall be furnished complete with all anchors and supports, all mechanical equipment required for proper operation, including a complete drive unit, and all additional material or construction required by the manufacturer's design.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.04. Identification. Vertical mixers shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, power drive assemblies, and accessories forming a part of the equipment furnished, shall be submitted in accordance

with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Mixers
- Name of manufacturer.
- Type and model.
- Tag number.
- Mixer location.
- Rotative speed.
- Number, size, and type of impeller(s).
- Impeller shaft size, material, and number of sections.
- Net weight of mixer unit.
- Dynamic forces of mixer.
- Maximum horsepower requirements.
- Ratio of rotative speed to critical speed of shaft.
- Electrical wiring diagrams.
- Electrical control equipment.

Support Platform
- Dimensional drawings of support platform and structural members.
- Details for connections between the platform and the existing concrete walls.
- Provide details on the coating system
- Details for connecting the mixer to the platform.

Motors
- As required by the Common Motor Requirements for Process Equipment section.

Gear reducers
- Type, specifications, details, input and output speeds, exact gear ratios, and service factor (24 hour continuous service).
- Manufacturer's certification.

Seismic Design Requirements
- Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instruction or parts lists packed with or attached to the equipment when delivered.

1-4. SPARE PARTS. Spare parts shall be provided as follows:

Spare Parts	Quantity
Complete sets of bearings and oil seals for each size/type of gear reducer.	1 per mixer

Oil filters per unit, where filters are required. 1 per mixer

Spare parts shall be suitably packaged with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

PART 2 – PRODUCTS

2-1. SERVICE CONDITIONS. Raw wastewater.

The mixing units shall be suitable for the following service conditions:

Ambient air temperature range.	55 to 85	°F
Mixer Tag Numbers	MXP-10, MXP-30	
Basin or process	Basin	
Type of environmental exposure.	Outdoor	
Liquid characteristics		
Liquid type	raw sewage	
Temperature	55 to 85	°F
Maximum solids concentration, by weight.	2	%
Chemicals introduced to the mixing zones	Ferric Chloride	
Water depth		
At average flow	22.9	ft
At maximum month flow	23.2	ft
At peak flow	24.4	ft
Total Flow rate (each train)		
Average	33.75	mgd
Maximum Month	46.96	mgd
Peak	85.00	mgd
Basin Dimensions		
Length	30’-0”	each
Width	8’-3”	each

Diameter	NA	ft

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The impeller water-horsepower requirements, gear losses, and an allowance for buildup on the impeller for each mixer shall be included in determination of the brake horsepower requirements.

	Rapid Mix Basin	Flocculation Basin	
Mixer Tag Numbers	MXP-10	MXP-30	
No. of Mixers	1	1	
Motor rating, max	15	1.0	Hp
Maximum motor speed	1800	1200	Rpm
Maximum impeller speed	37	25	Rpm
Minimum impeller diameter	64	66	In
Minimum Direct Pumping Rate	7,800	3,600	ft^3/min
Minimum Thrust/Momentum	20,000	700	$ft \cdot lb/s^2$
Uniformity of suspended solids concentration throughout mixed basin	Within ±10% of average	Within ±10% of average	
Mixer speed requirements	Constant Speed	Constant Speed	

2-3. ACCEPTABLE MANUFACTURERS. Mixing equipment shall be as manufactured by Philadelphia Mixing Solutions, Lightnin, Chemineer, Hayward Gordon, or equal. Drawing layout is based on Chemineer model 23GTD-15 in the Rapid Mix Basin and Chemineer model 21GTD-1 in the Flocculation Basin. Contractor to confirm pump size, weight, bending moment, torque, and installation procedures with the pump manufacturer selected. The Contractor shall provide any necessary modifications required by pump manufacturer including but not limited to: power requirements, mechanical design, and structural design.

2-4. MATERIALS. Each mixer shall be constructed of the following materials. All materials in contact with the liquid must be ferric chloride resistant.

Assembly Bolts and Nuts	
Stainless Steel	Bolts ASTM F593, Alloy Group 2
	Nuts ASTM F594, Alloy Group 2, of a

	lesser hardness than the bolts to prevent galling.
Flat Washers	ANSI B18.22.1; of the same material as the bolts and nuts.
Shafts – torque tube	316 stainless steel
Impeller Assembly (body)	316 stainless steel
Couplings	AISI Type 316 stainless

2-4.01. Bolts and Nuts. Field assembly bolts and nuts and anchor bolts in accordance with the Anchorage in Masonry and Concrete section shall be provided for each item of equipment.

All field assembly bolts, nuts, and washers in submerged, or exposed, locations shall be stainless steel. Field assembly bolts, nuts, and washers in other locations shall be hot-dip galvanized.

Anti-seize thread lubricant shall be applied to the threads of all stainless steel bolts.

2-5. CONSTRUCTION.

2-5.01. Drive Units. Drive units shall be designed for the specific requirements of mixer service and shall be suitable for 24 hour a day operation under moderate shock conditions. Each drive unit shall consist of an electric motor and a gear reducer. The use of gears mounted directly to the motor shaft will be allowed when approved by Engineer. Proposed motor and gear drive shall be submitted to Engineer for approval. Lifting lugs or support points shall be provided on each motor and gear reducer. One set of lifting lugs or support points shall be designed and located to permit lifting the complete mixer and drive unit. Motors shall be readily separated from gear reducers.

The gear reducer output shaft shall be constructed and supported such that shaft deflections caused by operating loads do not affect alignment of the anti-friction bearings, or cause gear misalignment.

All gear reducer and motor bearings shall be oil or grease lubricated, rolling element, antifriction type. Thrust bearings shall be provided to carry all shafting and impeller loads, plus an allowance of at least 25 percent of the weight of the shaft and impeller. No bearings shall be located below the bottom of the supporting platform.
The nominal input horsepower rating of each gear or speed reducer shall be at greater than or equal to the nameplate horsepower of the drive motor.

2-5.01.01. Gear Reducers. Each gear reducer shall be a totally enclosed unit, and shall be rated as specified in AGMA 6013-A06. Gear reducers shall be double or triple reduction type with helical or spiral bevel gearing, and shall have a gear quality of 10 or

higher. Worm gearing will not be acceptable. The helical or spiral bevel reducers shall have an AGMA service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Shaft mounted and flange mounted gear reducers shall be rated AGMA Class II. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall be designed and manufactured in compliance with applicable AGMA standards. The output shaft shall be enclosed in a drywell which provides positive leakproof sealing . The mixer shaft shall be rigidly coupled to the output shaft.

Gear reducers shall be specifically designed for mixer service. The gear reducers shall be selected, designed, and rated in accordance with the appropriate AGMA standards. The gearing shall be designed with a life factor at least equivalent to 10 million cycles, and an overall service factor of 2, based on the sum of the continuous loads plus any transient loads other than starting loads. Bearings shall have an ABMA L_{10} Life Rating of at least 100,000 hours, except output shaft bearings, which shall have an L_{10} rating of at least 200,000 hours. The mixer manufacturer shall submit evidence of having furnished equipment similar in size, torque, and shaft overhang, which has performed successfully for a period of at least 5 years.

Gear reducers shall include a doweled cast iron, fabricated steel, or FRP case and cover to ensure alignment of components under load.

The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F.

Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing. Oil lubricated units shall include a dipstick or sight glass, and ventilators and drain plugs.

Gear reducers which require the removal of parts or the periodic disassembly of the unit for cleaning and manual greasing of bearings will not be acceptable.

Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.

2-5.02. Mixer Supports. Each mixer shall be designed and mounted so that the motor and gear reducer can be removed from its box as a complete unit after the impeller is removed from the shaft. Each mixer shall be assembled on a rigid and substantial base. The base shall be attached to a mixer support bridge structure. The opening in

the mixer platform shall be large enough to permit removal of the shaft, including couplings, after removal of the impeller.

2-5.03. Impellers and Shafts. Mixer impellers shall be axial flow or radial flow. Impellers shall be removable, streamlined stress-free body without any mounted or fitted parts. Laminated stainless steel insert nuts shall be used to attach the impeller to the mixer shaft.

Axial flow impellers shall be of the hydrofoil, pitched blade, or HE turbine type. The impeller shall be an open type without balancing rings or discs.

Impeller design, arrangement, and operating speed shall provide efficient and proper mixing of the basin contents at any rate of flow through the mixing basin up to the peak rate of flow specified herein. Submerged or bottom steady bearings will not be acceptable.

The location of the impellers above the bottom of the mixing chamber or tank shall be as recommended by the manufacturer and shall be acceptable to Engineer. The shaft shall be of sufficient length and keyed to allow vertical adjustment of the impeller.

Vertical shafting for the impeller assembly shall be of ample size and design for the service intended and shall be supported and steadied so that the unit will operate without shaft whip or vibration. The mixer rotative speed shall be not more than 40 percent of the critical speed of the shaft (including impellers and appurtenances).

Stainless steel shafts shall be solid type or sheathed stainless steel shafts. Rigid type couplings shall also be fabricated from stainless steel.

Each impeller shaft (exclusive of shafting in the gear reducer) shall be constructed preferably in one section, but in no case more than two sections, as determined by the manufacturer. If furnished in two sections, the shaft shall be connected with a suitable rigid coupling.

Each impeller shaft shall connect to the gear reducer output shaft with a suitable rigid coupling. The gear reducer output shaft and the top half of the coupling need not be of stainless steel.

For axial and radial flow impellers, a metal cone boot element shall be provided at the bottom of the shaft but above the impeller. The cone shall be attached to the shaft and impeller blades by stainless steel set screws and shall be removable for mixer disassembly. The cone shall be 10-inches in height and shall have a diameter of 20-inches minimum. The purpose of the cone is to prevent impeller ragging.

2-5.04. Edge Grinding. Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius as necessary to ensure satisfactory paint adherence.

2-5.05. Surface Preparation. All welds shall be thoroughly cleaned and ground smooth in preparation for coating. All ferrous metal surfaces, except motors, speed reducers, and stainless steel, shall be solvent cleaned in accordance with SSPC-SP1 before shop primer is applied.

2-5.06. Mixer Support Bridges. Each mixer shall be supported as indicated on the Drawings. Alternate mixer mounting design proposals by Contractor will be considered by Engineer.

2-5.07. Electric Motors. The motors shall be designed as specified in the Common Motor Requirements for Process Equipment section.

2-5.08. Adjustable Frequency Drives. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Each unit shall be installed in accordance with Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. The equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. A minimum of 3 days of field time shall be provided by the manufacturer to supervise the installation of the mixer equipment.

All costs for these services shall be included in the contract price.

Manufacturers' installation supervisor shall observe, instruct, guide, and direct the installing contractor's erection or installation procedures. The equipment manufacturer will be provided with written notification 10 days prior to the need for such services.

3-2.03. Field System Operation Tests. Field system operation tests specified in the Startup Requirements section, shall be 30 days rather than the 7 days specified in the Startup Requirements section.

3-3. PERFORMANCE TEST. Performance tests shall be run on the mixing equipment after the installation check is completed, the units are operating properly as determined by the representative of the equipment manufacturer, and after acceptance of the Field System Operation Tests. The performance tests shall be conducted by a capable representative of the manufacturer and accepted by Engineer. After the test, drain all oil from each gearbox and refill it with the proper grade oil. All costs for these services shall be included in the contract price.

Owner's operating personnel will assist the manufacturer's representative in the performance test. A designated representative of Owner and/or Engineer will observe the performance tests.

Preliminary performance tests shall be conducted using the mixer under the design conditions specified. Once the appropriate operation parameters are established, extended duration performance tests shall be conducted to demonstrate the equipment's ability to consistently perform at the design conditions specified.

The test results will be used to prove compliance with the performance requirements prior to acceptance of the equipment. Consistent compliance with design conditions shall be defined as the average of sample values meeting or exceeding the specified design conditions.

The equipment manufacturer shall detail the proposed performance testing procedure and analyses, subject to approval by Engineer. If more than one day of testing is required, the testing shall be done on consecutive days.

In the event that the mixing equipment fail to meet the requirements as specified above, the necessary changes shall be made and the equipment retested. If the equipment remains unable to meet the specified requirements to the satisfaction of the Owner, the equipment shall be removed and replaced with satisfactory equipment as not cost to the Owner.

3-3.01. Suspended Solids Distribution Test. Not used.

3-3.02. Oxygen Uptake Rate Distribution Test. Not used.

3-4. TEST REPORTS. The equipment manufacturer shall prepare a formal test report, including all installation check and performance tests and other recorded data and observations. Two copies of the report shall be submitted to Engineer within 30 days after completion of the specified tests.

3-5. MODIFICATIONS. If the vertical mixing system equipment fails to satisfy the performance requirements as demonstrated by the suspended solids distribution test, equipment modifications shall be made, or additional equipment shall be furnished and installed, to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications, additional equipment, and retesting shall be at the expense of the Contractor. Modifications shall include structural, piping, or electrical modifications necessary to accommodate the modified equipment.

3-6. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is directly employed by the manufacturer, to instruct Owner's operating personnel in the proper operation and maintenance of the equipment. At least two days shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner, and shall take place prior to plat start-up and acceptance by the Owner. All costs for these services shall be included in the Contract Price.

3-6.01. Operations Training. Classroom instruction shall be provided covering the theory of operation, site specific operation of the equipment, and optimization of the vertical mixer operation.

3-6.02. Maintenance Training. Hands-on training shall be provided in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

3-6.03. Maintenance Assistance. Assistance to Owner shall be provided during the first year of operation when a unit shall be disassembled for inspection, cleaning, and/or maintenance. The Owner will schedule the maintenance assistance providing 2 weeks notice to the equipment manufacturer.

End of Section

Section 11727

LIQUID CHEMICAL FEED SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers liquid chemical feed equipment and accessories. Principal items to be furnished and installed shall include the following:

Ferric Chloride Feed System.

South River (SRWRC):
- Four quick connect adapters.
- Three duplex basket strainers.
- Three metering pumps.
- Three metering pump control panels.
- Three calibration columns.
- Three magnetic flowmeters.
- Three diffusers.

The following items of work and equipment are covered under other sections:

Piping and valves between items of equipment.
Water supply and electric power supply to the equipment.
Drain and vent piping.

1-2. LIQUID CHEMICAL FEED SYSTEM INTEGRATOR. The chemical feed systems shall be designed, coordinated, and supplied by a competent Liquid Chemical Feed System Integrator (herein referred to as System Integrator). The System Integrator shall be regularly engaged in the business of designing and assembling liquid chemical feed systems for water treatment or wastewater treatment plant projects. The System Integrator shall be responsible for ensuring that a complete functioning system is supplied for each Chemical Feed System. The System Integrator shall be responsible for coordinating all equipment, piping, and valves, and appurtenances for each Chemical Feed System and coordination with section 13500 System Supplier.

1-2.01 System Integrator Qualifications. The System Integrator shall meet all of the following requirements and within 30 days after the Notice of Award, the Contractor shall submit proof of the following qualifications for the intended System Integrator:

The System Integrator has successfully provided similar work for at least 5 years.

The names of at least three references who are users of similar systems designed, assembled, and furnished by the System Integrator.

The System Integrator has the required financial capability.

The names of manufacturers whose products will be supplied.

The System Integrator maintains a qualified technical staff and design office.

The System Integrator has the physical plant and fabricating personnel to complete the work specified.

The System Integrator has and will maintain competent service personnel to service the equipment furnished.

1-3. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.

Each item shall be furnished and installed complete with all mechanical and electrical equipment required for proper operation, all components indicated on the drawings or specified, and all additional materials or construction required by the design of the system.

1-3.01. Coordination. The System Integrator shall verify that each system component is compatible and consistent with all other components of the system, that all pipe materials and sizes are appropriate, and that all devices necessary for a properly functioning system have been provided. Devices and appurtenances necessary for a properly functioning system shall be constructed of materials consistent with the piping materials unless otherwise indicated. The System Integrator shall assume responsibility for ensuring that Minimum Suction Head and NPSH available is adequate for the supplied pumps.

Similar components of different chemical feed systems shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

Review of drawings submitted prior to the final determination and coordination of related equipment to be provided will not relieve the Contractor from responsibility for supplying systems in full compliance with the specific requirements of the related equipment.

1-3.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. Piping on skids shall be constructed consistent with the piping and valve specifications.

1-3.03. Governing Standards. All electrical equipment shall conform to applicable standards of the National Electrical Manufacturers Association and the National Electrical Code.

1-3.04. Power Supply. Unless otherwise specified, the power supply will be 480 volts, 60 Hz, three phase. Where control voltage lower than the power supply voltage is required, a suitable control power transformer shall be furnished. Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

1-3.05. Metal Thicknesses. Metal thicknesses and gauges specified herein are the minimum required. Gauges refer to US Standard gauge.

1-3.06. Nameplates. A nameplate shall be provided and mounted on or adjacent to each piece of chemical feed equipment to identify its function. Nameplates shall be approximately 1 by 3 inches, made from white on black phenolic material. Letters shall be engraved to the black interior and shall be at least 3/16-inch high. Feeder designations on the nameplates shall correspond to those indicated on the drawings.

1-3.07. Spare Parts. A list of recommended spare parts with pricing shall be furnished during the submittal phase.

1-4. SUBMITTALS. Submittals for chemical feed systems shall have the following organization and information as a minimum.

1-4.01 Submittal organization. The submittal shall be split up into different sections with a separate section for each chemical feed system. Each system section shall be supplied with the following information.

System Integrator Name, Contact Name, Phone Number, Address, and email address.

System Integrator Contact Name Qualifications and Experience

Bill of Materials

System piping and instrumentation diagram (P&ID) with legend

Equipment and piping layout starting from bulk storage tank pump suction nozzle to discharge of anti-siphon loop.
Metering pump selections
Metering pump appurtenances including calibration column

Control Panel layout and wiring diagram.

Diffuser selection.

Control narrative.

Spare parts

1-4.02. Drawings and Data. Complete fabrication, assembly, installation and equipment and piping layout drawings, piping and instrumentation diagrams, and wiring diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Section.

1-4.03. Calibration Graphs. The System Integrator shall prepare a calibration graph from field tests for each chemical feed pump. Each graph shall include a curve of pump speed versus gallons per hour at 10, 25, 50, 75 and 100 percent speed. Each graph shall be furnished on hard paper and sealed in clear plastic.

1-4.04. Control Narrative. A narrative description of the proposed metering pump controls, including all control modes, manual and automatic operations, electrical interlocks, alarms, and interfaces to the Plant Control System shall be submitted.

PART 2 - PRODUCTS

2-1. SYSTEM INTEGRATOR. The chemical feed system shall be coordinated, and supplied by a qualified System Integrator who is regularly engaged in the business of designing and assembling liquid chemical feed systems for water treatment or wastewater treatment plant projects.

2-2. CONSTRUCTION. Chemical feed equipment shall be of substantial construction with all parts designed for long life under working conditions including corrosive atmospheres and intermittent or continuous operation. All wearing parts and items requiring adjustment shall be readily accessible. Each unit shall be completely enclosed and dust-tight when in operation. All parts which are exposed to corrosive conditions shall be made from corrosion-resistant materials or covered with suitable protective coatings. Any ferrous cast iron components shall be coated with DuCoNite chemical resistant coating.

2-3. FERRIC CHLORIDE FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense ferric chloride to the following feed points indicated on the drawings. One assembly shall be installed at South River (SRWRC).

2-3.01. Quick Connect Adapters. Four quick connect adapters shall be provided at the truck unloading stations to connect the truck’s hose to the storage tank fill line as indicated on the drawings. The material of construction shall be compatible with the

chemical and approved by the Engineer. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the adapter type (grooved fitting) with a locking dust cap. The adapter shall be constructed of material suitable for the chemical service with female NPT threads for connecting to the fill piping. The adapters shall be the same size as the storage tank fill line as indicated on the drawings. The quick connect adapters shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, or equal.

2-3.02. Duplex Basket Strainers. Three duplex basket type strainers shall be furnished and installed on the truck unloading piping to the ferric chloride storage tanks as indicated on the Drawings. The strainers shall be the same size as the tank fill piping with PVC body with Viton seals and flanged connections and pressure rating of 150 psi at 70° F. The basket shall be PVC with no larger than 1/16-inch perforations. The strainers shall be as manufactured by Hayward or equal.

2-3.03. Hose-Type Peristaltic Metering Pumps. Three metering pumps shall be furnished and installed as indicated on the drawings to continuously dispense 38 percent ferric chloride solution with a specific gravity of 1.41 to the points of application indicated on the drawings.

	South River
Number of pumps	Three (3)
Designation	FECL-PPS-100 FECL-PPS-200 FECL-PPS-300
Feed Points	Filter Effluent (Emergency) Primary Clarifiers Junction Box Final Clarifiers
Capacity control range, percent	0 to 100
Metering range, gph	26.3 to 176
Minimum drive motor, hp	1.5
Accuracy, percent of scale over metering range	2
Discharge pressure, psi	60
Maximum rotor revolutions per minute	75

Manufacturer/Model Watson Marlow Bredel 20, Verderflex

The pump shall be of the positive displacement hose-type peristaltic pump, utilizing a flexible hose and shoe. The pump shall consist of a sealed, lubricant-filled cast iron housing, pump hose, rotor assembly, and one-piece connectors. The process fluid shall only contact the inside of the pump hose.

The pumps shall be either closed-coupled or “SPX-Direct Coupled” by the Manufacturer. Bareshaft/coupling arrangements shall not be acceptable.

The pump hose shall be three-layer reinforced hose consisting of a natural rubber outer layer, braided nylon reinforcing layer, and an inner wetted layer of material resistant to the solution as acceptable to the Engineer. The hose insert shall be constructed of materials resistant to the solution as acceptable to the Engineer. The hose shall be of 53-68 durometer with a static burst pressure of 600 psi. The hose shall be in contact with the inside diameter of the track through an angle of 180 degrees and shall be held in place on the suction and discharge by a one-piece cast sealing gland. Hose-clamp type fittings shall not be acceptable. The hose shall be replaceable without removing the pump or opening the pump head door. Inlet/outlet connectors shall be one solid piece constructed of materials resistant to the solution as acceptable to the Engineer. Inlet/outlet connectors shall be located by and secured to the pump housing by permanent stainless steel nuts, washers, and bolts.

The rotor assembly shall be equipped with two sliding shoes. Shoes shall be located 180 degrees apart for complete occlusion of the hose against the track twice per rotor revolution. Each rotor assembly shall be keyed to the output shaft of the gear reducer/gearmotor and be axially secured to the shaft by a heavy-duty washer and socket head cap screw. Each rotor assembly shall have ribbed spokes which will create constant circulation of lubricant upon rotation to enhance lubrication and cooling within the pump housing.

The rotor housing shall be equipped with a PMMA inspection window.

The pump shall be completely self-priming with a suction lift capability of up to 20 feet. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and not utilize any dynamic seals in contact with the pumped liquid.

The pump housing shall contain a threaded drain plug and vent port. The drain shall be located at the lowest point in the housing and shall allow complete removal of all liquid from within the housing.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these

appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

The pump shall be provided with a float type magnetic reed switch located at the top of the pump to detect leakage of pumped solution into the pump housing. The float switch shall be rated for 50 volts ac.

One transparent PVC bodied Y-pattern strainer with 12-mesh screen and O-ring seals.

Suction and discharge pulsation dampeners shall be provided with each pump. Dampeners shall be appendage type and consist of a two-part housing, bell-shaped bladder, and one-way air inlet valve to prevent backflow and shall be equipped with a pressure gauge.

One pressure gauge and high pressure switch with isolating diaphragm. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees.
The unit of measurement shall be pounds per square inch, and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The high pressure switch shall be of the diaphragm type, shall have a weatherproof housing, shall have a trip point reliability better than 1 percent of actual pressure, and shall at minimum be SPDT rated at 10 amp at 120 VAC. The isolating diaphragm shall protect the pressure gauge from the chemical solution.

One external relief valve sized to pass the maximum displacement of the pump.

Each pump shall have a dedicated control panel located in the electrical room as indicated on the drawings. Each control panel shall house the VFD drive and control components required for operation of the metering pump as specified herein. The control panel shall be a fiberglass or Type 316 SS NEMA Type 4X enclosure suitable for wall mounting in the location indicated on the drawings. Each control panel shall contain controls and status for the metering pump as described herein, and as indicated on the drawings. Each control panel shall be provided with a red running light for each pump to indicate when the motor is running, a yellow “Failure” light to indicate a drive fault, and a white “Failure” light to indicate leakage at the pump. Each control panel shall also include an “ON-OFF-REMOTE” selector switch for each metering pump.

Where a high discharge pressure switch is indicated on the drawings or specified to be provided for the pump, the pump shall shut down on high discharge pressure. Where a leak detection system is indicated on the drawings or specified to be provided for the pump, the pump shall shut down on leakage and an amber “Diaphragm Failure”

indicating light on the panel front shall illuminate. Additional controls shall be provided as indicated on the drawings.

Each pump motor shall be equipped with electric speed adjustment to operate from a VFD controller. The signal input to the controller shall be 4-20mA ac, and shall be ungrounded differential type, with an input resistance of not more than 250 ohms. The controller shall accept either a remote signal or a manual rate control signal, and shall vary the ac voltage to the motor, with feedback as required to attain the desired rate.

Each VFD controller shall operate from a 480 volts ac, three-phase, 60 Hz power supply, and shall be mounted in the control panel, specified in Section 17570. A manual rate setter and a rate indicator shall also be mounted on the face of the control panel. Additional controls shall be provided as indicated on the drawings.

2-3.03.01. Calibration Columns. Three transparent plastic calibrating columns shall be furnished and installed on the pump suction piping as indicated on the drawings.

The three columns at South River shall each be a 6-inch ID clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and 1-inch screwed flow fitting. Each column shall be graduated in 0.1 gallon increments over a range of 0 to 3.0 gallons, complete with a numeral at each graduation.

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on legs constructed of Type 316 stainless steel.

2-3.04. Magnetic Flowmeters, Signal Converters, and Accessories.

2-3.04.01. Magnetic Flowmeter. Three magnetic flowmeters shall be provided per requirements of section 17562. All wetted flowmeter components shall be highly corrosion resistant as approved by the Engineer.

2-3.04.02. Magnetic Flowmeter Signal Converters. Each magnetic flowmeter shall be provided with a magnetic flowmeter signal converters. Each magnetic flowmeter signal converter shall be provided per requirements of 17562.

2-3.05. Diffusers. Three diffusers shall be provided as indicated on the drawings.

2-4. SAFETY EQUIPMENT. One chemical handling safety equipment kits shall be provided. Each kit shall include, but shall not be limited to, chemical splash goggles, canister type dust and mist respirator, rubber gloves, and rubber apron, all packed in a suitable carrying case.

PART 3 - EXECUTION

3-1. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with Drawings, specifications, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer. All items necessary for a complete operating system shall be installed.

3-1.01. Equipment Bases. Unless otherwise specified or indicated on the Drawings, each item of chemical feed equipment shall be mounted on a concrete base approximately six inches above the floor. If feeders or other components must be supported at higher elevations above the floor, suitable supplementary bases shall be provided.

3-1.02. Installation Check. An experienced, competent, and authorized representative of the System Integrator shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when equipment is placed in operation in accordance with Section 01650 and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The System Integrator's representative shall furnish a written report certifying that the equipment has been properly installed; that gas piping has been properly cleaned; is in accurate alignment; is free from undue stress imposed by connecting piping or anchor bolts; and has been operated at full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price for the number of days and round trips to the site as required.

3-2. CLEANING. At the completion of installation and testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3-3. TRAINING. The System Integrator shall provide a qualified representative at the jobsite for one day (eight hours) to train the Owner's personnel in operating and maintaining the equipment.

End of Section

Section 13231

DIGESTER/SLUDGE TANK CLEANING

PART 1 - GENERAL

1-1. SCOPE. All work specified in this section shall be considered an additive alternative, and will be performed upon authorization by the Owner and the Engineer. This section covers the removal of all liquid, scum, and accumulated (settled) solids from the tank(s); cleaning of tank walls and floors, sludge disposal; and inspection for the Digester No 1 at ICWRC and includes the following items of work:

Preliminary work as necessary to provide proper access to the interiors of the tanks.

Furnishing all labor, materials, tools, chemicals, equipment or process machinery as well as all trucks and suitable containers, supplies, personnel, odor and noise control, safety devices, and supervision, and all other requirements necessary for the complete removal and disposal of liquid , (including water and supernatant from the digester, and centrate and/or filtrate from the dewatering system), accumulated solids, sludge, grit, scum, and all other debris deposited in the tank(s) .

The Contractor shall transport the dewatered solids and all inorganic or organic debris removed from the tanks from the Site to an approved disposal site. The contents of the hauling units may be checked at the disposal site for conformance with the manifest that shall accompany each load to the disposal site. Contractor shall perform all testing on the hauled material as required by the disposal site.

After removal and disposal of tank contents, the Contractor shall wash all interior surfaces of the tanks and dispose of wash water prior to final inspection.

The Contractor shall take precautions to prevent leakage or spillage onto the property, roadways, drainage system, and waterways. The Contractor shall be liable for clean-up costs or any fines that may be levied including those by regulatory agencies, against the Owner in the event that a leak or spill occurs. The Contractor shall also be responsible for reporting spills to the appropriate regulatory agencies including the Georgia Environmental Protection Division.

The Contractor shall maintain a clean work site, remove debris and dispose of it properly at the Contractor's expense. Upon completion and before making application for acceptance of the Work, the Contractor shall remove all rubbish, temporary structures, and equipment, and repair all damage caused by the Contractor.

The Contractor shall make all necessary repairs described on the Drawings and in the Specifications or discovered after cleaning of the surfaces prior to reinstating the tank(s) into service.

1-2. GENERAL REQUIREMENTS. Prior to the cleaning operation, the plant operations staff will decommission each tank to be cleaned. The Contractor shall drain/pump sludge from the tank.

The Contractor shall drain and pump settled sludge from the tank, dewater the solids, and dispose of the screenings and dewatered solids at an approved disposal site. The Owner will accept, treat, and dispose of the filtrate or centrate delivered through the Contractor's temporary piping system, to the existing transfer pump station, provided the stream is nonhazardous and not harmful to plant processes. Contractor shall be responsible for determining size of pipe, length of piping, pumps, ancillary equipment, and any connections required to pipe centrate to the existing transfer pump station.

The Contractor shall remove and reinstall access man-ways and bolted hatches, and shall remove temporary connections to the sludge piping system required for the Work. After the Work is completed, the Owner or Engineer will inspect the manways, bolted hatches, and piping connections. If necessary, the Contractor shall remove and reinstall the equipment that is not installed in accordance with the Owner's requirements. Contractor shall conform to all Owner requirements and training for Confined Space Entry.

1-3. SUBMITTALS. The following shall be submitted in accordance with the requirements of the Project Document Tracking and Control Systems section:

Injury and Illness Prevention Program or Health and Safety Plan.

Procedures for cleaning each tank including:

Description of processes, methods, and equipment to be used, including pumps, valves, piping, screening and dewatering equipment, electrical and control systems, chemical and water systems.

Sketch showing layout of temporary screening and dewatering facility, and proposed route for trucks from the Site to the disposal site.

Drawings for proposed routing of temporary piping and electrical connections, showing all the plant interface connections.

Estimated quantity of settled sludge to be processed. Contractor shall submit estimated quantity as wet tons, as dictated in the Bid Form.

Estimated quantity of liquid side streams (digester or storage tank supernatant, centrate, filtrate, wash water, etc.) and solids (screenings and dewatered cake solids) generated.

Manufacturer's product specification sheets for all chemicals to be used in the dewatering operation.

Description and location of the permitted disposal facility for dewatered solids and screenings solids (if different).

Proposed hauling schedule to disposal facility.

Description of mitigation measures for odors, noise, and spills, and a description of housekeeping procedures for temporary screening and dewatering facility and spill abatement and clean up.

1-4. CONTRACTOR QUALIFICATIONS. The Contractor shall have completed at least five similar projects within the past five years. The Contractor shall own or rent all major equipment used in the cleaning operation, including pumps, screening, and dewatering equipment.

Personnel performing the Work shall be qualified to operate all equipment and be properly trained to comply with all OSHA safety requirements. All Contractor employees shall be certified in confined space entry and first aid. Proof of equipment ownership and Contractor qualifications shall be submitted at the time of bidding.

1-5. COORDINATION. Contractor shall meet with the Owner at the beginning of the Project to coordinate the Owner's requirements for maintaining plant operations and decommissioning the tank to be cleaned before preparing the Progress Schedule. The Contractor's schedule shall include time required by the Owner to decommission the digester/tank and to maintain operation of the Owner's solids handling process. Decommissioning procedures and the estimated time required are outlined in the Project Requirements section. The Contractor shall notify Owner at least 3 weeks prior to the date Contractor wants to start dewatering and cleaning of the digester tank. The Owner will cooperate with the Contractor to the extent allowed by the Owner's operations requirements, to facilitate the cleaning work.

The digester cover shall be removed by the Contractor prior to digester cleaning. The cover shall be demolished and disposed of in accordance with the demolition section of the specifications.

Contractor shall exercise care to prevent damage to the digester or tank structure while removing and demolishing the cover, sludge and gas piping, and associated appurtenances.

1-6. TANK PARAMETERS. Digester and EQ tank

The tanks have the following parameters:

Tank tags	Digester No. 1	
Tank inside diameter	100	ft
Cover type	Floating	
Approximate tank volume, each,	1.5 MG	
Approximate side wall depth	25.5	
Approximate liquid depth	NA	

The information in the table above is based on operational history; the actual solids concentration of the settled sludge in the digester is unknown and will vary at depths within the tank. No sampling of the digester solids quantity has been preformed and it shall be the responsibility of the Contractor to determine and track quantity that is removed and disposed.

PART 2 – PRODUCTS – Not used.

PART 3 - EXECUTION

3-1. PRELIMINARY WORK. Contractor shall be responsible for all preliminary work and equipment necessary to provide proper access to the interior of each tank for the work required.

Contractor shall furnish necessary pumps, pipes, hoses, pipe connections, valves, and related appurtenances needed to supply water to and remove the material (including the water) from each tank. The Contractor shall provide the equipment necessary including dewatering pumps, sludge pumps, grinders, and other equipment which may be used to remove the contents of the tank(s).

Potable water shall be used for all cleaning operations. Contractor shall install a meter and record all potable water use. Contractor shall be responsible for all potable water cost associated with the cleaning of the digester.

Owner will close and lock out all isolation valves on the sludge piping and digester gas piping prior to of the Contractor's work. All pipes shall be plugged prior to beginning work. Plugs shall be removed at the conclusion of cleaning.

The atmosphere inside the tank(s) consists of methane and other gases. Contractor shall be responsible for furnishing and operating all air quality testing, hazard monitoring equipment, and ventilation equipment as required to provide adequate protection for workmen and to eliminate explosion hazards. The Contractor shall ensure that each tank has been purged and is free from all explosive gas before performing any work in the tank.

Power for the cleaning work will be provided as specified in the Temporary Facilities section.

3-2. SCREENING AND DEWATERING. The Contractor's screening equipment, where specified or used by Contractor's preference, and dewatering system shall be in good working condition capable of handling 150 to 250 gpm of throughput. The maximum screen opening shall be 3/8 inch. The equipment used for dewatering shall produce a cake with a consistent solids content of 18 percent or greater and achieve a solids capture rate of 90 percent or greater.

Polymer shall be used by the Contractor, where required to meet the specified sludge cake and solids capture requirements. The Contractor shall provide containment for all polymer storage and handling. Dewatering shall not produce excessive odors and noise, shall be contained in the area for dewatering indicated on the Drawings, and shall be completed in a manner which does not impede plant operations, cause a plant upset, or create a nuisance for plant personnel or nearby residents.

The Contractor shall furnish all required pumping, piping, and related appurtenances to convey the liquid stream from the dewatering equipment to the disposal point located at the existing transfer pump station.

During the cleaning operation, the Owner's operations staff will monitor the plant performance. Further limitation of the liquid stream return flow to the disposal point may be required to meet the operational needs of the Owner. The Contractor shall make adjustments in liquid stream flow required by the Owner, at no additional cost to the Owner.

3-3. TESTING AND RECORDS. Before each truck load leaves the Site, the Contractor shall take a composite grab sample consisting of a minimum of 6 subsamples, for testing at an independent laboratory approved by the Owner. Testing shall determine total solids concentration. Other testing shall be performed as required by the landfill where solids are disposed and may include pH and presence of free liquids in accordance with SW-846, Method 9095 (Paint Filter Liquids Test). The costs of sampling and testing at the independent laboratory shall be included in the Contract Price.

The Contractor shall maintain records for each truck load of dewatered solids hauled from the site and submit these to the Owner after tank is cleaned. Records shall include the total solids concentration, weight of the load, and dry tons for each truck load. The records shall be accompanied by the independent lab reports and tickets from the landfill documenting loaded and tare weight for each load.

3-4. VENTILATION. Sufficient forced ventilation shall be provided to remove sludge gas at a rate required to maintain safe working conditions. Contractor shall be responsible for furnishing and operating all ventilating equipment in a safe manner and testing air for hazardous conditions to provide adequate protection for workers inside

the tanks and to eliminate explosion hazards. All ventilating equipment operated inside the tank(s) shall be rated for operation in Class 1, Division 1, Group C and D hazardous areas.

3-5. COMPLIANCE WITH REGULATIONS. Compliance with local, state, and federal regulations concerning emissions or disposal of solid, particulate, liquid, or gaseous matter as a result of the cleaning and other operations shall be the responsibility of the Contractor. Any fines imposed on the Owner or Engineer by any regulatory agency as a result of the Contractor's noncompliance with environmental regulations shall be paid or reimbursed by the Contractor.

3-6. INJURY AND ILLNESS PREVENTION PROGRAM (IIPP) OR HEATH AND SAFETY PLAN. The Work shall be performed in accordance with the Contractor's IIPP or Health and Safety Plan which shall cover all aspects of health and safety that may be encountered during the course of the Work. The plan shall be in compliance with all applicable federal, state, and local safety regulations. The plan shall include a confined space entry policy and program, plan for operations in hazardous areas, fall protection plan, identification of the Contractor's competent person, and training certificates of employees involved in the cleaning of the tank(s), including evidence of completion of confined space entry training, CPR training, and first aid training.

3-7. SURFACE CLEANING. Contractor shall pressure wash all interior tank surfaces to remove deposits of grease, sludge, oil, contaminants, and similar materials. The waste wash water shall be removed from tank and disposed of as specified herein. Materials or chemicals if used in the cleaning process, that would be hazardous or harmful to the plant processes, shall not be discharged to the plant and shall be disposed of in accordance with federal, state, and local regulations. If cleaning of the tank surface results in damage to the surfaces, including, but not limited to, spalling of concrete or coating removal, the Contractor shall cease the cleaning operation and notify the Owner or Engineer immediately.

3-8. TANK INSPECTION. After the contents of the tank have been removed and surfaces have been cleaned, Contractor shall notify Owner. Tank shall be inspected by Owner, Engineer, and Contractor to determine extent of surface repair and coating. The Contractor shall require the attendance of all involved parties, including but not limited to the Contractor's superintendent and concrete repair contractor. The Contractor's rigging shall provide access to all surfaces for inspection once the tank cleaning is complete and Owner and Engineer shall be allowed use of rigging for inspection.

3-9. SURFACE AND COATING REPAIR. Refer to DIVISON 09 FINISHES.

3-10. RESTORATION. After all work is completed, Contractor shall remove and dispose of all temporary piping and facilities. A final inspection by Owner and Engineer

will be performed to confirm that the work has been satisfactorily completed in accordance with the Owner's requirements.

End of Section

Section 13340

PRECAST CONCRETE ENCLOSURE

PART 1 - GENERAL

1-1. SCOPE. One precast concrete enclosure shall be provided and erected as specified herein in the location shown on the Drawings. The enclosure shall be provided complete with doors, hardware, and all appurtenances as specified herein.

1-2. GENERAL. The Headhouse Stairway Enclosure shall be erected on the top slab of the Headhouse concrete vault as indicated on the Drawings. The enclosure shall be designed, fabricated, erected, and equipped in accordance with all applicable codes, laws and regulations, and as specified herein. Wall openings for HVAC and electrical equipment shall be provided at locations indicated on the drawings. Contractor shall confirm wall opening sizes and locations based on furnished equipment and coordinate these requirements with the enclosure manufacturer prior to submitting shop drawings.

To ensure proper coordination, all enclosure appurtenances shall be obtained and provided by the enclosure manufacturer.

1-3. SUBMITTALS. Complete shop drawings and product data shall be submitted in accordance with the Submittals Procedures section. Shop drawings illustrating the design, fabrication and assembly of the enclosure shall be sealed by an engineer registered in the State of Georgia. Submittals shall include design calculations, data on concrete mix design, details on the method of attachment between slab and walls, 8 in x 8 in sample of finish, and hardware submitted shall include color chart.

PART 2 - PRODUCTS

2-1. PRECAST ENCLOSURE. The Headhouse Stairway Enclosure shall be a precast, reinforced concrete structure with walls and roof. The enclosure shall be manufactured with a mechanism for assembly under tension and shall be provided with joints to be caulked with a urethane sealant compound to maintain a permanent seal under severe weather conditions. All joints shall be finished and caulked, and concrete on the interior shall be smoothed to remove any projections.

Concrete shall be 5000 PSI minimum 28-day compressive strength, air-entrained. All inserts shall be bolted directly to form before casting panels. No floating–in of connection inserts shall be allowed.

All precast enclosures for this project shall be manufactured by the same company. The Precast Concrete Enclosure section was written around the Easi-Span Buildings

system by Easi-Set Industries, Midland, VA; but equal systems will be acceptable from other manufacturers.

2-1.01. Structural Design Criteria. The enclosure and products specified herein shall be designed to meet the general, wind, snow, ice, and seismic requirements as indicated in the Meteorological and Seismic Design Criteria Section, as well as all applicable loading criteria defined on the Structural Notes Sheet.

2-1.02. Enclosure Dimensions. The enclosure shall have minimum interior dimensions as indicated on the drawings.

2-1.03. Post-tensioning Strands. Roof shall be post-tensioned in field after keyway is filled and cured to required PSI strength. Post-tensioning cables shall be 41K polystrand CP50, ½ inch, 270 KSI, 7-wire strand, enclosed within a greased plastic sheath (ASTM A416).

2-1.04. Finish. The exterior walls shall have a brick style concrete pattern with cant strip extension at base and roof line. Exterior color shall match surrounding structures and shall be approved by the Owner. Interior finish shall be smooth form finish, unpainted.

2-1.05. Roof. Roof panel shall have a minimum slope of ¼ inch per foot. Roof may be monoslope or gable. The roof shall extend 3 inches beyond wall panels and include a turndown roof with built-in drip edge. Roof shall have two (2) coats of elastomeric coating.

2-2. DOORS AND FRAMES. The exterior door opening shall allow for a 3'-0" x 7'-0" clear opening and shall be as indicated in the Steel Doors and Frames section. Door hardware shall be as indicated in the Door Hardware section.

2-3. ROLLING STEEL INSULATED DOOR. Not Used.

2-4. INSULATION. Not Used.

2-5. OPENINGS. In addition to door openings, there shall be openings provided for:

Intake Louver: 24" W x 8" H
Exhaust Wall Fan: 13" W x 13" H

PART 3 - EXECUTION

3-1. COORDINATION. Prior to delivery of the enclosure, the base and floor shall be prepared by the Contractor as indicated on the Drawings. All conduits shall be installed and extended to a minimum of 12 inches above the finish floor elevation. Dimensions of

the prepared base shall extend beyond the outside dimensions of the enclosure slab by a minimum of 1 inch on all sides. Slab shall have 1 inch chamfered edges.

Manufacturer shall erect enclosure at the site. Contractor shall coordinate construction of slab, delivery of enclosure, and erection of enclosure with manufacturer.

3-2. SHOP INSPECTION. The Owner may, at their option, visit the shop to observe/inspect enclosure casting and fabrications. The Contractor shall notify the Owner a minimum of one (1) month in advance of casting. The enclosure manufacturer shall provide convenient access to the location of the work and shall cooperate to facilitate inspections.

3-3. INSTALLATION. Enclosure shall be set level. Panels shall be fastened together with ¼ inch thick (minimum) galvanized steel brackets (ASTM A283, Grade C) to meet loading requirements. Panel fasteners shall be ½ inch diameter (minimum), ASTM A307, carbon steel. Wall panels shall be connected to floor slab with stainless steel adhesive anchors with quantity, diameter and embedment depth to meet loading criteria.

3-3.01. Panel Joints. All joints between panels shall be caulked on the exterior and interior surface of the joints in accordance with the Joint Sealants section.

3-3.02. Roof Joints. All joints between panels shall be caulked on the exterior and interior surface of the joints in accordance with the Joint Sealants section.
Roof may be constructed of one (1) solid piece thus eliminating any roof joints.

End of Section

Section 13750

TIGHTNESS TESTING OF STRUCTURES

PART 1 - GENERAL

1-1. SCOPE. This section covers hydrostatic tightness testing of concrete structures.

Tightness testing, cleaning, and disinfection of steel storage reservoirs and tanks, elevated steel tanks, and piping systems are covered in other sections.

1-2. GENERAL. Unless otherwise specified, testing shall be completed prior to placement of backfill, cleaning and disinfection, and prior to the installation of equipment in the structure.

All testing work shall be performed by Contractor in the presence of Engineer.

1-2.01. Testing Schedule and Procedure. A testing schedule and procedure shall be submitted to Engineer for review and acceptance not less than 30 days prior to commencement of testing. The schedule shall indicate the proposed time and sequence of testing for each structure. The procedure shall indicate the limits of the area to be tested, define the method of isolation, the position and use of valves during testing, the location of temporary bulkheads, the process for introducing water and air into the structure, the method of measuring water and air losses, any correction methods required due to evaporation and precipitation, the method and location for disposal of testing water, and any other activities relevant to the testing.

Contractor shall notify Engineer at least five days in advance of the time that testing of any individual structure will begin.

1-2.02. Water. Water for testing will be furnished as stipulated in the temporary facilities section. Water shall be conserved through collection and reuse in subsequent tests. Following completion of testing work, the water shall be disposed of in a manner acceptable to Engineer and, unless otherwise permitted by Engineer, shall not be allowed to enter other parts of the system.

PART 2 - PRODUCTS

2-1. TEST EQUIPMENT. All necessary connections between the structure to be tested and the water source or other test medium, together with pumping equipment, any necessary metering devices, pressure or vacuum gauges, and all other equipment, materials, and facilities required to perform the specified tests and dispose of the test

medium after completion of testing, shall be provided by Contractor. Contractor shall provide all required temporary flanges, valves, bulkheads, bracing, blocking, and other sectionalizing devices that may be necessary to perform the testing. All temporary devices shall be removed upon satisfactory completion of testing.

2-2. STRUCTURES TO BE TESTED. The structures to be tested are indicated in the Tightness Testing of Structures schedule.

2-3. ALLOWABLE WATER LOSS. The maximum allowable water loss and the test duration shall be as specified in the Tightness Testing of Structures schedule.

Adjustments for evaporation and precipitation shall be required when indicated in the schedule. A partially filled plastic pan or tub having dimensions proportionately similar to those of the basin shall be placed in the basin and monitored to account for evaporation or rainfall.

Each leak which is discovered during the correction period shall be located and repaired to the satisfaction of Owner by and at the expense of Contractor.

PART 3 - EXECUTION

3-1. HYDROSTATIC TEST PROCEDURES. The hydrostatic test shall consist of both a visual inspection and a water loss measurement. Both tests shall be completed to the satisfaction of Engineer. The procedure and sequence of testing shall be subject to review and acceptance by Engineer.

Unless otherwise specified, tightness testing shall be performed after all pipe sleeves have been installed but before backfilling or the interior waterproofing material or coating has been applied or exterior dampproofing material has been applied.

Paint that has been applied to piping, valves, or other items shall be permitted to dry in accordance with the paint manufacturer's instructions prior to introducing test water into the tank.

Exposed concrete surfaces of the structure, including the floor, shall be cleaned of all foreign material and debris prior to the test. Standing water in or outside the structure that would interfere with observation of the exposed concrete surfaces shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired prior to filling the tank with water.

Adjacent structures having common walls shall be tested individually at different times to permit examination of the dividing walls for leaks.

Pipe connections or openings to structures, if not provided with drip tight valves, shall be temporarily plugged during testing. Where slide gates, sluice gates or similar devices are located, Contractor shall provide bulkheads or the means to make them drip tight, and measure any leakage.

Unless otherwise specified, each structure to be tested shall be filled with potable water at a uniform rate not to exceed a depth of 4 feet per hour to the level specified in the Tightness Testing of Structures schedule. The water shall be allowed to stand for at least three days prior to tightness testing in order to stabilize the absorption rate of the concrete and the water temperature. During this period, sufficient water shall be added to maintain the water level to the elevation specified.

3-1.01. Visual Inspection. All structures to be tested shall be free from visible leaks. Damp spots on exterior wall surfaces shall be considered visible leaks if moisture can be picked up on a dry hand. Damp spots on tops of wall footings will be permitted unless the water can be observed to be flowing. Repairs shall be made to visible leaks regardless of the water loss test results. All visible leaks which have not spontaneously plugged or demonstrated a definite decrease in the rate of leakage over a maximum period of 28 days shall be located and repaired by and at the expense of Contractor in a manner acceptable to Engineer. The structure shall be retested to confirm that the repairs are satisfactory.

3-1.02. Water Loss Measurement. Measurements of water level and loss will be taken by Engineer each day over the test period. If the measured drop in water level, adjusted for evaporation and precipitation when applicable, exceeds the allowable amount specified in the Tightness Testing of Structure schedule and does not show a definite decreasing trend during the following 7 day period, the structure shall be drained, repaired, cleaned, refilled, and retested to the satisfaction of Engineer.

Testing shall be considered void and the basin shall be retested in the event of excessive evaporation or precipitation that results in an empty or overflowing pan.

3-1.03. Structure-Specific Requirements. Additional requirements with respect to specific structures are defined in the following subparagraphs.

3-1.03.01. Concrete Clearwell. Not used.

3-1.03.02. Filter Boxes. Not used.

3-1.03.03. Reservoir. Not used.

3-1.03.04. Basins and Flume. Not used.

3-1.03.05. Washwater Holding Basin. Not used.

3-1.03.06. Washwater Recovery Basin. Not used.

3-1.03.07. Carbon Slurry Tanks. Not used.

3-1.03.08. Pump Wet Pit. The pump pit wells shall not be tightness tested until the roof slab for the structure is constructed and has reached its design strength.

3-1.03.09. Ozone Contact Basin. Not used.

3-1.04. Disposal of Test Water. Contractor shall confirm that Owner intends to dispose of the test water. If the water is to be disposed of, Contractor shall verify there is no residual chlorine or other undesirable product in the test water to be discharged. If necessary a neutralizing chemical treatment shall be provided to condition the water prior to disposal. Contractor shall be responsible to determine a suitable location and method for disposing of the used test water. Water discharged to overland disposal or to a sewer system shall be discharged at flow rates and locations acceptable to the local governing agencies and in compliance with applicable rules and regulations.

3-2. PNEUMATIC TEST PROCEDURES FOR OZONE CONTACT BASINS. Not used.

End of Section

Schedule 13750 - S01

TIGHTNESS TESTING OF STRUCTURES

Structure	Hydrostatic Testing				Pneumatic Testing	
	Water Surface Elevation	Allowable Water Surface Drop	Test Duration	Consider Evaporation and Precipitation	Allowable Pressure Loss	Test Duration
	ft	inches	days	(Y/N)	inches WC	minutes
ICWRC - Headworks Facility; 48” Pipe	822.82	No measure-able loss	7	Y	N/A	N/A
ICWRC - Headworks Facility; Channel Block	822.82	No measure-able loss	7	Y	N/A	N/A
IRWRC – Transfer Pump Station	812.50	No measure-able loss	7	Y	N/A	N/A
SRWRC - Primary Clarifiers PCLR-B2, B3, & B4	800.60	No measure-able loss	7	Y	N/A	N/A
SRWRC - Primary Clarifiers Scum Well	796±	No measure-able loss	7	Y	N/A	N/A
SRWRC - Primary Clarifiers – Junction Box	798.33	No measure-able loss	7	Y	N/A	N/A
SRWRC - Primary Clarifiers – Distribution Box	802.80	No measure-able loss	7	Y	N/A	N/A
SRWRC - Influent Diversion Box	785±	No measure-able loss	7	Y	N/A	N/A

Section 14622

MONORAIL ELECTRIC WIRE ROPE HOISTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of electric wire rope hoists, trolleys, monorail systems, and accessories as indicated herein.

Hoist designation.	Headhouse Pump Hoist	Transfer Pump Station Hoist
Number of hoists.	1	1
Hoist tag numbers.	TBD	TBD
Hoist location.	Headhouse superstructure	Transfer Pump Station superstructure

Each hoist and monorail system shall be furnished and installed in the location and arrangement indicated on the Drawings, complete with all hoisting equipment, monorail systems and electric wiring (including collectors, conductors, and conductor supports), controllers, pendant control station, and all other accessories necessary for a complete and properly operating installation.

1-2. GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Owner or Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification

differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories (UL) safety requirements.

Equipment furnished under this section shall comply with the applicable requirements of the following:

Occupational Safety and Health Standards of the U.S. Department of Labor; Subpart N, Materials Handling and Storage.

ANSI/ASME B30.10, "Hooks".

ANSI/ASME B30.11, "Monorails and Underhung Cranes".

ANSI/ASME B30.16, "Overhead Hoists (Underhung)".

ANSI MH27.1, "Specifications for Underhung Cranes and Monorail Systems".

ANSI/ASME HST-4, "Performance Standard for Overhead Electric Wire Rope Hoists".

1-2.04. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase. Power supply for controls shall be 120 volts, 60 Hertz, single phase unless otherwise indicated or required for a properly operating system. Control power voltage shall be derived from the main equipment power supply.

1-2.05. Labels. Each hoist and trolley shall have a conspicuous, easy-to-read label showing the manufacturer's name and the rated capacity. The rated capacity of the hoist shall also be shown on the load block.

1-2.06. Identification. Monorail electric wire rope hoists shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, together with detailed specifications, schematic and wiring diagrams, and data covering materials, parts, devices, accessories forming a part of the equipment furnished, and load test certificates, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers be referenced on the wiring and schematic diagrams where applicable.

Drawings shall include electrical connection diagrams and schematics identifying all items requiring electrical control or power in the operation of each electrically operated hoist and motor driven trolley, and complete details and information on the power feed system.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. QUALITY ASSURANCE.

1-4.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Owner's/Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Owner or Engineer upon request.

1-4.02. Manufacturer's Certification. The hoist manufacturer shall certify that each hoist provided has been load tested in accordance with ANSI/ASME B30.16 with a load of at least 125 percent of the rated load. A certificate shall be submitted for each hoist supplied and shall include the name of the project, the serial number on the hoist, and a description of the test performed. Testing of each hoist shall be the responsibility of the manufacturer and the certification shall be submitted before the hoist will be accepted for the project.

1-4.03. Contractor's Qualification. Contractor shall submit qualifications to do the work. Each monorail system shall be designed, coordinated, and supplied by a qualified Supplier who is regularly engaged in the business of designing and assembling monorail systems. The supplier shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years. Contractor shall submit proof of the following qualifications for the intended supplier of each system:

The Supplier has the required financial capability.

The names of manufacturers whose products will be supplied.

The Supplier maintains a qualified technical staff.

The Supplier has the physical plant and fabricating personnel to complete the work specified.

The names of at least three references who are users of similar systems designed, assembled, and furnished by the Supplier.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The wire hoist and trolley will service the equipment in the Headhouse and Transfer Pump Station. At each location, the monorail hoist system will be installed on an open-air steel frame structure and be capable of lifting pumps and other equipment from the lower level as shown on the Drawings. The trolley will move the equipment as needed between the loading bay area and the basement access openings as shown on the Drawings.

All equipment shall be designed to operate under the following service conditions:

Seismic design requirements.	See Meteorological and Seismic Design Criteria section	
Type of environmental exposure.	Outdoor(open)	
Ambient air temperature range.	0 to 110	°F

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Each hoist, trolley, and monorail system shall conform to the performance and design requirements as follows:

Hoists

Tag number	TBD	TBD	
HMI hoisting duty classification.	H1	H1	
Hoisting capacity.	2	6	tons
Elevation of hook at highest position.	812	827.5	ft
Elevation of hook at lowest position.	787	790.5	ft
Minimum vertical travel of lifting hook.	Per hoist specification	30	ft
Maximum distance between bottom of monorail and inside of lifting hook in highest position.	Per hoist specification	24	in
Motor type	Single speed	Single speed	
Hook lifting speed.	15	15	ft/min

Hook lifting speed, minimum/maximum.	5 to 7		ft/min
True vertical lift required	No	Yes	
Trolleys			
Type	Electric	Electric	
Maximum trolley clearance above bottom of monorail.	Per trolley specification	8	in
Motor type	Singlespeed	Two speed	
Travel speed.	50		ft/min
Travel speed, minimum/maximum.	13 to 20	13 to 20/40 to 60	ft/min
Monorails			
Type	Monorail track	Monorail track	
Operating floor elevation.	787	809 (Top of Pump Station)	ft
Bottom of monorail elevation.	816	827.5	ft
Maximum depth of monorail track.	7		ft
Approximate length of monorail.	140		ft
Power feed system	Track mounted power bar	Festooned cable	

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers for electric wire hoists and trolleys shall be Yale, Lift-Tech International, Morris/P&H, R&M Material Handling Inc., Konecranes, or equal.

Equivalent products of manufacturers regularly producing hoist, trolley, and monorail systems, shall be subject to acceptance by Owner and Engineer.

All modifications necessary to accommodate the hoist, trolley, or monorail systems shall be subject to acceptance by Engineer and shall be made at no additional cost to Owner.

2-4. HOIST AND TROLLEY. The hoist and trolley arrangement shall be spur-geared hoist type or low headroom type.

Each hoist and trolley shall be protected against the weather and shall be suitable for outdoor operation.

2-4.01. Hoist. Each hoist shall consist of an electric motor, a grooved winding drum, and gearing, arranged with the trolley. Antifriction bearings shall be used throughout. The winding drum shall have machined grooves designed to receive the full run of hoisting cable without overwrapping. The ratio between the diameter of the drum and the diameter of the hoisting cable shall be at least 20 to 1. At least two laps of cable shall remain on the drum when the lifting hook is in the lowest position.

2-4.01.01. Gears and Bearings. Hoist gearing shall be spur or helical type and shall be fully enclosed in an oiltight housing. All bearings shall be antifriction type, with oil lubrication or lifetime grease packing.

2-4.01.02. Load Brakes. Each hoist shall be provided with mechanical and electrical load brakes arranged so that the load may be raised or lowered by electric power and automatically sustained at any position of the hook when the power is cut off. The mechanical load brake shall prevent acceleration of the load when lowering and shall completely sustain the load when brought to rest, independent of the electric brake. The electric brake shall be released whenever current is flowing to the hoist motor and shall be automatically activated when the current is shut off or interrupted. The mechanical load brake shall operate in oil in a sealed enclosure.

2-4.01.03. Limit Switches. Each hoist shall be provided with adjustable limit switches to stop the hoisting mechanism at the upper and lower limits of hook travel.

2-4.01.04. Lifting Tackle. The lifting tackle shall consist of a lower block and hook, necessary sheaves, and wire rope made especially for hoisting service. Wire rope shall be as recommended by the rope manufacturer for use on the specified drum. The lower block and hook shall be of the safety type, with guarded sheaves and a slow opening, nonfracturing, forged steel hook. The hook shall have antifriction bearings to permit easy turning, and shall include a safety latch. The sheaves shall have antifriction or sleeve type bearings.

2-4.02. Trolley. Each trolley shall have a rated capacity equal to or greater than the capacity of the corresponding hoist.

Each trolley frame shall be rigid and shall be the underhung type. The trolley frame shall be provided with lugs or wrap around side plates on both sides of the runway beam or monorail track. Wheels shall be single flange type. Wheels shall be made from rolled, forged, or cast steel, machined universal crowned or tapered treads of hardened steel. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

Each trolley shall be constructed to provide necessary clearances at all track joints, splices, and hangers, including all projections on any track opener sections and switches.

If curved tracks are indicated on the Drawings, each trolley shall be designed to operate on curved sections having the radii indicated on the Drawings.

2-4.02.01. Manual. Not used.

2-4.02.02. Electric. The trolley drive shall be a sealed worm or spur gear unit, permanently lubricated with an oil bath. Drive wheels shall have integrally cut spur gear teeth or machine-cut gears pressed on hubs. Drive wheel treads shall be hardened.

When a festooned power cord type power system is required, the hoist trolley shall have a suitable member to contact and push the bumper of the adjacent conductor cord trolley.

2-5. MONORAIL SYSTEMS. The monorail systems shall be one of the following as indicated on the Drawings and as specified in the Structural and Miscellaneous Metals section:

- Runway beams as indicated on the Drawings and as specified in the Structural and Miscellaneous Metals section
- A proprietary monorail track system furnished complete with monorail track, a track suspension system, and appurtenances indicated on the Drawings, specified, or required for a complete, properly operating installation acceptable to Engineer. The monorail track system shall be as manufactured by TC/ American Monorail, Inc., Acco Louden Supertrack®, or equal.

2-5.01. Track. The monorail track shall be capable of supporting the weight of the hoist and trolley and the specified load, plus an impact factor of 25 percent of the specified load, with a limiting deflection of 1/450 of the span between supports.

Joints shall be close-fitting and free from unevenness. Track sections shall be rigidly supported in exact alignment. Where indicated on the Drawings, curved sections shall be carefully formed to radius and shall be free of warp and distortion.

Removable stops shall be provided on each end of each monorail track to limit hoist travel. Stops shall conform to the governing standards and shall be so located that the hoist does not come into contact with any part of the structure or piping or encroach on any clearances.

When a festooned power cord type power system is specified, the power feed end of the monorail shall have stops designed so that the power cord trolleys will pass beneath the stops. The stops shall be located so that there is sufficient room on the monorail for storage of the cord trolleys beyond the stops. Secondary stops shall be provided for the cord trolleys.

2-5.02. Track Suspension System. The monorail track manufacturer shall furnish the

track suspension system, which shall consist of all track hangers, hanger rods, clamps, brackets, braces, supports, fasteners, and appurtenances required to support the track system from the structure, as indicated on the Drawings. Unless otherwise permitted, track loads shall be applied at the load points indicated and shall not exceed the values indicated on the Drawings.

2-5.03. Track Opener. Not used.

2-5.04. Track Switches. Not used.

2-6. ELECTRICAL.

2-6.01. Motors. Hoist and trolley motors shall be totally enclosed, high-starting torque, squirrel-cage type, designed especially for hoist and trolley service and suitable for operation with the specified power supply. Motor size and speed shall be adequate to start the fully rated load capacity.

Motors shall be furnished with motor space heaters. Motor space heaters shall be powered from the control power transformer and shall be of the voltage rating as recommended by equipment manufacturer.

2-6.02. Controllers. Controllers shall be of the reversing, magnetic contactor type, with thermal overload protection, and shall be installed at the motor and operated from a pendant station. The trolley controller shall be an adjustable frequency drive for cushioned starting and stopping.

Control of hoist and trolley motions shall be from a remote pendant pushbutton station. The pendant station shall contain individual pushbuttons for hoist up and down and trolley forward and reverse. The remote pendant shall be capable of controlling the hoist from anywhere in the Headhouse or Transfer Pump Station main floor or basement.

The pendant docking/charging station shall be 4 feet above finished floor.

Pushbuttons shall be of the mechanical or electrical interlocking type to prevent the possibility of damage to equipment should two or more buttons be depressed simultaneously. Pushbuttons shall be provided with a spring return to the "Off" position when pressure on the button is released.

A control power transformer, with one secondary lead fused and the other grounded, shall be provided to reduce voltage at the pendant station to 120 volt ac or less as recommended by equipment manufacturer.

The pendant and controls for each hoist shall be protected against the weather and shall be suitable for outdoor operation.

2-6.03. Power Feed System. A complete electric power feed system shall be provided for each hoist and trolley and shall be as specified below.

2-6.03.01. Cable Reel Power Feed System. Not used.

2-6.03.02. Festooned Cable Power Feed System. A festooned power feed system shall be provided and shall consist of a portable power cord festooned in loops from power cord trolleys installed on the bottom flange of the monorail. Power cord trolleys shall have ball bearing wheels, a swivelling cord clamp suitable for the size of cord provided, and integral bumpers to prevent contact between the wheels and the hoist or the hoist trolley. A sufficient number of cord trolleys shall be provided to ensure a minimum 6 foot headroom between the bottom of cord loops and adjacent equipment or the floor, and to permit proper movement of trolleys around curved portions of the monorail.

The power cord shall be 600 volt, neoprene jacketed, heavy-duty portable cable suitable for wet locations. The power cord shall be rated for hoist and trolley full load amperes at 167°F [75°C] copper temperature. A watertight seal connector, of sufficient size to pass full cord diameter, and a woven stainless steel strain-relief grip shall be provided at each end of the cord. Grips shall be aligned parallel to the monorail and shall not interfere with extension or retraction of the cord. A junction box with cover hub sized for the power cord connection shall be provided. The box, mounting, and cover attachment shall be suitable for the maximum applied cord tension.

2-6.03.03. Track-Mounted Power Bar Feed System. A track-mounted power bar feed system shall be provided and shall consist of copperelectrogalvanized insulated conductors and insulated collector assemblies with copper-graphite collector shoes, and shall be U-S Safety Trolley's "Span-Guard", Conductix-Wampfler Insul-8 “8-Bar” or Duct-O-Wire "Duct-O-Bar", or equal 4-bar insulated conductor system. The current and voltage rating of the conductors and collectors shall be adequate for the maximum electrical load.

Stationary conductors shall be installed adjacent to the track switches and track opener sections (if specified), with supports and brackets as needed. Insulated travelling collector assemblies shall be installed on the hoist trolley and wired to the hoist. Conductors and collectors shall be installed in compliance with the recommendations and instructions of the system manufacturer.

If the track extends, via a track opener, to the exterior of the structure, the interior and exterior track sections shall be separately and independently powered, so that the hoist and trolley can be operated on either the interior or exterior monorail with the track opener section either open or closed. The conductor system on the exterior section shall be weatherproof. Curved conductor sections shall be provided where required for a curved track.

The branch circuit for each hoist will be furnished and installed under the Electrical section and at the location indicated on the Drawings. A suitable junction box with all hanger brackets and other accessories required for a complete installation shall be furnished and installed under this section, and the branch circuit wired in.

2-6.04. Wiring. All insulated wire shall be heat-resistant and shall be insulated for 600 volts.

PART 3 - EXECUTION

3-1. ERECTION. Each hoist and trolley and monorail system shall be erected in accordance with the manufacturer's recommendations by workers who are regularly engaged in hoist and track erection and who are acceptable to the equipment manufacturer.

3-2. WIRING. All wiring on the hoist system shall be installed in intermediate metal conduit in accordance with the National Electrical Code.

3-3. FIELD QUALITY CONTROL.

3-3.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

End of Section

SECTION 14700

SCREENINGS DUMPSTERS

PART 1 - GENERAL

1.01 SCOPE

Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required to manufacture and install all screenings dumpsters. All equipment shall be fabricated, installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

Related work specified elsewhere:

1. Section 05120, Structural Steel.
2. Section 09900, Painting.
3. Section 11330, Coarse Screening System.

1.02 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's certification.
2. Manufacturer's data.

1.03 QUALITY ASSURANCE

Reference Standards. Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. OSHA, Occupational Safety and Health Act.
2. ANSI, American National Standards Institute.
3. ASTM, American Society for Testing Materials.
4. AISI, American Iron and Steel Institute.

Experience. Equipment furnished under this Section shall be of a design and

manufacture that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications. Provide a list of such installations complete with installation description contact names, addresses, telephone numbers. This reference list shall be submitted with the shop drawings.

1.04 QUALITY STANDARDS

The screenings dumpsters shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions. A certificate of unit responsibility shall be provided. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for this portion of the work.

Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the pump manufacturer shall not be accepted.

Manufacturer's offering products that comply with these specifications include:

1. Earl Soesbe Company, Inc.
2. Or equal.

1.05 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 GENERAL

The screenings dumpster function is to collect solids removed from the flow caught by the multi-rake screens.

The dumpsters shall be designed such that when loaded it will be top heavy. When released by the manually pulled latch, the dumpster shall roll over and dump. Unloaded, the dumpster shall roll back to the upright position and lock.

The screenings dumpsters shall be stable and self supporting under empty and loaded conditions and shall be steel with a minimum thickness of 1/4". The bottom surface shall be perforated to allow water drainage. The dumpster shall be shop coated with corrosion resistant coatings after fabrication.

Each screenings dumpster shall be approximately 60 inches wide and a maximum 48 inches high with approximately 2.0 cubic yard capacity. Exact dimensions for each unit shall be coordinated by the Contractor to insure adequate operating clearances.

PART 3 - EXECUTION

3.01 INSTALLATION

Prior to dumpster fabrication, the Contractor shall verify that the specified size dumpster has sufficient clearance for transport and dumping by overhead crane. Once onsite, the Contractor shall test the system for operability.

Any damage to the dumpster surface shall be corrected by the Contractor in accordance with Section 09900, Painting.

End of Section

Section 15010

VALVE INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the installation of new valves and actuators purchased by Contractor as part of this Work.

Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections.

The following specification sections are applicable to valves to be installed:

Title
Miscellaneous Ball Valves
Check Valves
Plug Valves
Miscellaneous Valves

1-2. GENERAL. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Any valves and actuators that are identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

1-2.01. Coordination. When manufacturer's field services or installation check services are provided by the valve manufacturer, Contractor shall coordinate the services with the valve manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services.

Submittals for equipment that will be furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria. Flanged, push-on, and grooved connections to valves including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section. Valve ends shall match piping.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3-1. INSPECTION. All valves and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3-2. INSTALLATION.

3-2.01. General. Valves shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the valve for in-place maintenance. Installation shall be in accordance with the valve manufacturer's recommendations.

Unless otherwise indicated on the Drawings or specified, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches [1.3 m] or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of piping having centerline elevations between 4 feet 6 inches [1.3 m] and 6 feet 9 inches [2 m] above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation, as reviewed by Engineer.

3-2.02. Installation Checks. When specified in the valve sections, the valve manufacturer will provide installation checks. For installation checks, the manufacturer's field representative will inspect the valve installation immediately following installation by Contractor. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

Contractor shall perform no work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.

3-2.03. AWWA Butterfly Valves. Butterfly valves shall be installed with the shaft horizontal unless otherwise necessary for proper operation or as acceptable to Engineer.

Whenever an actuator must be removed to permit installation of a valve, the actuator shall be promptly reinstalled and shall be inspected and readjusted by a representative of the valve manufacturer.

3-2.04. Check Valves.

3-2.04.01. Lift Check Valves. Horizontal lift checks shall be installed in a level horizontal position so that the internal parts rise and fall vertically, unless the valve is spring loaded. Angle pattern lift checks shall be installed in vertical pipe with flow upward from beneath the disc.

3-2.04.02. Swing Check Valves. Install valves oriented for the correct flow direction. Only valves designed for vertical installation shall be installed in vertical piping.

3-2.04.03. Low Pressure Air Service Check Valves. Dual disc wafer check valves installed in the discharge piping of centrifugal blowers shall be positioned with the valve hinge perpendicular to the impeller shaft of the blower.

3-2.05. Plug Valves.

3-2.05.01. Eccentric Plug Valves. Eccentric plug valves shall be installed with the shaft horizontal and the plug in the upper half of the valve body. Valves in horizontal wastewater, sludge, or scum lines shall be installed with the seat on the upstream end. Valves in all vertical piping shall be installed with the seat at the upper end of the valve.

3-2.06. Resilient Seated Gate Valves.

3-2.06.01. Resilient Seated Gate Valves. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendices to ANSI/AWWA C509 and C515 and with the recommendations of the manufacturer.

3-2.06.02. Double Disc Gate Valves. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendix to ANSI/AWWA C500 and with the recommendations of the manufacturer.

3-2.07. Air Release and Combination Air Valves. Not used.The exhaust from each valve shall be piped to a suitable point acceptable to Engineer. Air release valve exhaust piping leading to a trapped floor drain shall terminate at least 6 inches [150 mm] above the floor.

3-2.08. Hydrants. Not used.

3-2.09. Valve Boxes. Valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After each valve box is placed in proper position, earth fill shall be placed and thoroughly tamped around the box.

3-3. VALVE ACTUATORS. Valve actuators and accessories shall be factory mounted on the valve, calibrated, and tested by the valve or actuator manufacturer.

3-4. FIELD QUALITY CONTROL.

3.4.01. Field Testing. After installation, all valves shall be tested in accordance with the Pipeline Pressure and Leakage Testing section.

3-4.01.01. Pressure Tests. Pressure testing shall be in accordance with the Pipeline Pressure and Leakage Testing section.

3-4.01.02. Leakage Tests. All valves shall be free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor. This requirement applies whether pressure testing is required or not.

3-5. ADJUSTING. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic and electric actuated valve.

End of Section

Section 15020

MISCELLANEOUS PIPING AND ACCESSORIES INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the installation of piping and accessories as indicated on the Drawings for the following piping sections:

Section Title
Miscellaneous Piping and Accessories
Miscellaneous Steel Pipe, Tubing, and Accessories
Miscellaneous Plastic Pipe, Tubing, and Accessories

Contractor shall furnish all necessary jointing materials, coatings, and accessories that are specified herein.

Pipe supports and anchors shall be furnished by Contractor, and are covered in the Pipe Supports section. Pipe trenching and backfilling are covered in the Trenching and Backfilling section.

1-2. GENERAL.

1-2.01. Coordination. Materials installed under this section shall be installed in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by Engineer.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Items requiring submittals shall include, but not be limited to, the following:

Watertight/dust tight pipe sleeves.

Materials as specified herein.

1-3.02. Welder Certification. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified. Copy of certification and identification stamp shall be submitted for each welder. Qualification tests may be waived if evidence of prior qualification is deemed suitable by Engineer.

1-4. QUALITY ASSURANCE.

1-4.01. Welding and Brazing Qualifications. All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be submitted to the Engineer for review.

1-4.02. Tolerances. These tolerances apply to in-line items and connections for other lines.

The general dimension, such as face-to-face, face or end-to-end, face- or end-to center, and center-to-center shall be 1/8 inch [3 mm].

The inclination of flange face from true in any direction shall not exceed 3/64 inch per foot [4 mm per meter].

Rotation of flange bolt holes shall not exceed 1/16 inch [1.5 mm].

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

Plastic pipe, tubing, and fittings shall be stored between 40°F and 90°F [4°C and 32°C].

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Pipe, tubing, and fittings covered herein shall be installed in the services indicated in the various pipe sections.

2-2. MATERIALS.

Threaded Fittings

Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Never-Seez "Pure Nickel Special", or Permatex "Nickel Anti-Seize".
Teflon Thread Sealer	Paste type; Hercules "Real-tuff", John Crane "JC-30", or Permatex "Thread Sealant with Teflon".

Teflon Thread Tape	Hercules "Tape Dope" or John Crane "Thread-Tape".
Solvent Welded Fittings	
Solvent cement for PVC Systems	ASTM D2564.
Solvent cement for CPVC Systems	ASTM F493.
Sodium Hypochlorite, Sodium Hydroxide, and Sodium Bisulfite Service	IPS Corporation "Weld-On 724"
Primer for PVC Systems	ASTM F656.
Solder or Brazed Fittings	
Solder	Solid wire, ASTM B32, ANSI/NSF 61 certified, Alloy Grade Sb5, (95-5).
Soldering Flux	Paste type, ASTM B813.
Brazing Filler Metal	AWS A5.8, BCuP-5; Engelhard "Silvaloy 15", Goldsmith "GB-15", or Handy & Harman "Sil-Fos".
Brazing Flux	Paste type, Fed Spec O-F-499, Type B.
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".
Pipe Insulation	See Mechanical Insulation section**.**
Watertight/Dusttight Pipe Sleeves	O-Z Electrical Manufacturing "Thruwall" and "Floor Seals", or Thunderline "Link-Seals"; with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts.

Pipe Sleeve Sealant	Polysulfide or urethane, as specified in the Caulking section or as indicated on the Drawings.
Protective Coatings	
Tape Wrap	ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils [760 µm]; Protecto Wrap "200" or Tapecoat "CT".
Primer	As recommended by the tape manufacturer.
Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy for aeration and process air piping	Shop or field applied high solids epoxy; suitable for protection at continuous pipe wall temperatures up to 300 F. Coating shall be abrasion resistant. The finished coating shall have a minimum total film thickness of 10 mils. The surface shall be prepared in accordance with SSPC-SP7 as a minimum unless otherwise recommended by the coating manufacturer. The coating shall be Carboline “Thermaline 450”, PPG Amercoat “Amerlock 400 with Amercoat 880 Additive”, or approved equal.
Chlorine Tank Car Unloading Connection	Special flanged hose assembly conforming to materials and details on Drawing No. 135, The Chlorine Institute, Inc.

PART 3 - EXECUTION

3-1. INSPECTION. All piping components shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original

requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3-2. PREPARATION.

3-2.01. Field Measurement. Pipe shall be cut to measurements taken at the site, not from the Drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3-3. INSTALLATION.

3-3.01. General. All instruments and specialty items shall be installed according to the manufacturer's instructions and with sufficient clearance and access for ease of operation and maintenance.

Flat faced wrenches and vises shall be used for copper tubing systems. Pipe wrenches and vises with toothed jaws will damage copper materials and shall not be used. Bends in soft temper tubing shall be shaped with bending tools.

3-3.02. Pipe Sleeves. Piping passing through concrete or masonry shall be installed through sleeves that have been installed before the concrete is placed or when masonry is laid. Pipe sleeves installed through floors with a special finish, such as ceramic or vinyl composition tile, shall be flush with the finished floor surface and shall be provided with nickel or chromium plated floor plates. Unless otherwise indicated on the Drawings, in all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch [25 mm] nor more than 2 inches [50 mm] above the floor surface, with the projections uniform within each area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the Drawings indicate future installation of pipe, sleeves fitted with suitable plastic caps or plugs shall be provided.

Holes drilled with a suitable rotary drill will be considered instead of sleeves for piping which passes through interior walls and through floors with a special finish.

Unless otherwise indicated on the Drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements.

Piping shall be made dusttight and gastight with special rubber-gasketed sleeve and joint assemblies; with sleeves sealed with modular rubber sealing elements; or by caulking with oakum and polysulfide or urethane sealant, when passing through the following locations:

Headhouse basement walls

3-3.03. Pipe Joints. Pipe joints shall be carefully and neatly made in accordance with the indicated requirements.

3-3.03.01. Threaded. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed after threading and before assembly to remove all burrs. Unless otherwise indicated, threaded joints shall be made up with teflon thread tape, thread sealer, or a suitable joint compound.

Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads. Threaded joints in steel piping for chlorine service shall be made up with teflon thread tape or litharge and glycerine paste applied to all male threads.

3-3.03.02. Compression. Ends of tubing shall be cut square and all burrs shall be removed. The tubing end shall be fully inserted into the compression fitting and the nut shall be tightened not less than 1-1/4 turns and not more than 1-1/2 turns past fingertight, or as recommended by the fitting manufacturer, to produce a leaktight, torque-free connection.

3-3.03.03. Flared. Ends of annealed copper tubing shall be cut square, and all burrs shall be removed prior to flaring. Ends shall be uniformly flared without scratches or grooves. Fittings shall be tightened as needed to produce leaktight connections.

3-3.03.04. Soldered and Brazed. Where solder fittings are specified for lines smaller than 2 inches [50 mm], joints may be soldered or brazed at the option of Contractor. Brazing alloy shall contain no tin.

Surfaces to be joined shall be thoroughly cleaned with flint paper and coated with a thin film of flux. At each joint, tubing shall enter to the full depth of the fitting socket.

Care shall be taken to avoid overheating the metal or flux. Each joint shall be uniformly heated to the extent that filler metal will melt on contact. While the joint is still hot, surplus filler metal and flux shall be removed with a rag or brush.

3-3.03.05. Solvent Welded. Solvent welded connections shall only be used for PVC or CPVC pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the setting time recommended by the manufacturer. Pressure testing of solvent welded piping

systems shall not be performed until the applicable curing time, as set forth in Table X2.1 of ASTM D2855, has elapsed. Solvent welding shall be performed by bonding operators who have met the requirements of ASME B31.3 and A328.

3-3.03.06. Epoxy and Adhesive Bonded. Epoxy and adhesive bonded joints shall only be used for FRP pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. After joining, either the pipe or the fitting shall be rotated approximately one-half turn to uniformly distribute adhesive. A slight fillet of adhesive at the bond line is desirable, but all excess adhesive shall be wiped off immediately. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the curing period recommended by the manufacturer.

3-3.03.07. Heat Fusion Bonded. Heat fusion bonded joints shall be used for polyethylene pipe with socket and butt fusion fittings. All joint preparation, cutting, jointing equipment, and jointing procedures shall comply with the pipe manufacturer's recommendations. The heating time, temperature, pressure applied to the joint during bonding, and cooling time shall consistently produce leaktight joints as strong as the pipe being joined.

3-3.03.08. Flanged. Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but shall not be torqued less than the minimum value required by the gasket manufacturer. Flange bolts shall not be so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.

Flange bolt holes shall be oriented as follows, unless otherwise indicated on the spool drawings:

Vertical flange face:	Bolt holes to straddle the vertical centerlines.
Horizontal flange face:	Bolt holes shall be aligned with connecting pipe.

Pipe sealants, thread compounds, or other coatings shall not be applied to flange gaskets unless recommended by the gasket manufacturer for the specified service and approved by Engineer.

Welds at orifice flanges shall have internal surfaces ground smooth to the pipe wall.

Slip-on flanges shall be welded inside and outside. There shall be a distance of approximately 1/16 to 1/8 inch [1.5 to 3 mm] between the edge of the fillet weld and the face of the flange. The seal weld shall be applied so that the flange face shall be free of weld spatter and does not require refacing.

Flat-faced flanges shall be used when mating to Class 125 flanges. Full-face gaskets shall be used with flat-faced flanges and ring gaskets shall be used with raised faced flanges.

Weld neck flanges shall be used with butt-weld fittings. The bore of weld neck flanges shall match the pipe wall thickness.

Insulating joints connecting submerged (buried) piping to exposed piping shall be installed above the maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged (buried) metallic piping shall be isolated from the concrete reinforcement. Insulating flanges shall be tested for electrical isolation after installation and bolt-up but prior to introduction of conducting fluid.

3-3.03.09. Welded. Welding shall conform to the specifications and recommendations contained in the "Code for Pressure Piping", ANSI B31.1.

Weld cross-sections shall be equal to or greater than the pipe wall thickness. Welds shall be smooth and continuous and shall have interior projections no greater than 1/16 inch [1.5 mm]. Backing strips or rings shall not be used except with specific prior review by Engineer as to use, material, and design. Root gap inserts that are completely melted and consumed in the weld bead are acceptable only when reviewed in advance by Engineer.

Stainless steel welding shall be inert gas tungsten arc (TIG) or the direct current, straight polarity, inert gas metal arc process (MIG).

Carbon steel welding shall be made by the shielded metal arc process.

For socket weld joints, fully engage the two pipe ends, then separate them by 1/16 inch prior to welding to all space for shrinkage.

3-3.03.10. Grooved Couplings. Grooves for grooved couplings shall be cut with a specially designed grooving tool. Grooves cut in steel pipe shall conform to flexible grooving dimensions, as set forth in AWWA C606, and shall be clean and sharp without burrs or check marks.

3-3.03.11. Push-on. Gasket installation and other jointing procedures shall be in accordance with the recommendations of the manufacturer. Each spigot end shall be suitably beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

3-3.03.12. Rubber-Gasketed. Rubber-gasketed joints for hub and spigot type cast iron soil pipe shall have plain spigot ends, without beads. Cut ends of all pipe shall be cut square, beveled, and all burrs shall be removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps for hubless cast iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

3-3.03.13. Other Pipe Joints. Coupled joints in tempered glass pipe, plastic joints in vitrified clay pipe, and other proprietary type joints shall be made in accordance with the manufacturer's recommendations and to the satisfaction of Engineer.

3-3.04. Pipe. Pipe shall be installed as specified, as indicated on the Drawings, or, in the absence of detail piping arrangement, in a manner acceptable to Engineer.

Piping shall be installed without springing or forcing the pipe in a manner which would induce stresses in the pipe, valves, or connecting equipment.

Piping shall be supported in conformance with the Pipe Supports section.

Piping shall be connected to equipment by flanges or unions as specified in the various piping sections. Piping connecting to equipment shall be supported by a pipe support and not by the equipment.

Water, gas, and air supply piping shall be provided with a shutoff valve and union at each fixture or unit of equipment, whether or not indicated on the Drawings, to permit isolation and disconnection of each item without disturbing the remainder of the system. Air supply piping shall be provided with sectionalizing valves and valved air inlet connections as needed for isolation of portions of the system for periodic testing. Gas supply lines to buildings shall be provided with a shutoff valve and union located above grade immediately outside the building. A capped drip leg shall be provided at the bottom of the vertical riser of gas supply piping adjacent to gas-fired appliances.

A union shall be provided within 2 feet [600 mm] of each threaded-end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping adjacent to devices or equipment which may require removal in the future and where required by the Drawings or the Specifications.

All air piping shall be graded to points of drainage collection where drip legs and drain valves shall be provided. Air piping shall be sized for the service conditions, with the indicated minimum sizes:

Service	Minimum Size
Air signal	1/4 inch OD [6 mm OD]
Power air	1/2 inch OD [13 mm OD]

Air supply	1/2 inch OD [13 mm OD]
Bubbler drop pipes	3/4 inch [19 mm]
Buried piping	3/4 inch [19 mm]

Water supply piping within structures shall be arranged, and facilities provided, for complete drainage. All piping serving metering equipment shall be uniformly graded so that air traps are eliminated and complete venting is provided.

All digester gas piping shall be graded to points of drainage collection where drip legs and drip traps shall be provided. Drip traps are covered in the Digester Gas Control Equipment section.

Stuffing box leakage from water sealed pumps shall be piped to the nearest point of drainage collection.

Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a ball type shutoff valve.

Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.

In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.

Buried PVC piping shall be "snaked" in the trench and shall be kept as cool as possible during installation. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation.

All chemical piping shall be installed so that lines are readily accessible for cleaning. Tees shall be provided at regular intervals in all chemical piping except chlorine piping, with extra openings plugged, to facilitate cleaning. Teflon thread tape or teflon thread sealer shall be applied to the threads of the plugs so that they can be easily removed. At each point where hose or reinforced plastic tubing is connected to rigid piping, a quick-disconnect coupling shall be provided.

Vent and gas piping for anhydrous ammonia, chlorine and sulfur dioxide gas shall be installed so that liquid traps are avoided. The open end of each vent line shall elbow down and shall be provided with a corrosion-resistant insect screen.

Double-contained chemical feed piping shall be installed according to the manufacturer's recommendations. Joints shall be solvent cemented. Splitting and rewelding of fittings will not be acceptable. Suitable drains and vents shall be provided to permit complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be designed to allow continuous drainage in the annular space to the drain ports. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment can be readily drained and manually inspected for leaks.

Polyethylene piping shall be installed in accordance with the manufacturer's recommendations. A continuous 12 AWG THHN insulated copper tracer wire shall be placed 6 inches [150 mm] above all portions of the buried pipe, but no more than 18 inches [450 mm] below the ground surface. Where the pipe extends above grade, a 2 foot [0.6 m] length of wire shall be coiled and attached to the pipe.

Piping adjacent to flow sensors shall be installed in accordance with the requirements of the manufacturer of the flow sensor and commonly accepted design practices of the appropriate straight pipe runs both upstream and downstream.

Drains required for operation are shown on the Drawings. However, vents at all high points and drains at all low points in the piping that are required for complete draining for pressure test may not be shown on these Drawings. Contractor shall add such items as found to be necessary during detail piping design and/or piping installation.

3-3.05. Reducers. Eccentric reducers shall be installed flat on the bottom for steam, condensate return and digester gas services.

3-3.06. Valves. Isolation valves provided with equipment and instruments shall be located in a manner which will allow ease of access and removal of the items to be isolated. Prior to soldering or brazing valves, teflon and elastomer seats and seals shall be removed to prevent damage.

3-4. PIPING ASSEMBLY.

3-4.01. General. Contractor shall only use labor that has been qualified by training and experience to capably perform the specified activities required to accomplish the work in a satisfactory manner

Any deviations from the Specifications or piping locations shown on the Drawings require prior review and approval by Engineer.

3-4.02. Buttwelded Piping. The specification and qualification of weld joints and welders for buttwelded piping shall be in accordance with ASME Boiler Pressure Vessel Code, Section IX, Welding and Brazing. Weld procedure specifications (WPS) and procedure qualification reports (PQR) shall be submitted to Engineer for review and validation of joint design, efficiencies and strength before installation begins.

Nondestructive examination (NDE) shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination. The minimum level of NDE shall be as follows:

(1) 100 percent visual examination of welds by a qualified examiner (per ASME B31.1), and

(2) Radiographic testing (RT) of 10 percent random sampling of welds.

If the Contractor wants to use alternative techniques or intends to apply alternative methods considered equivalent to those indicated herein, a proposal on such techniques or methods shall be submitted in writing to Engineer for review and approval at least 14 days before intended date of use.

Welding shall not begin until weld joint and welder qualification submittals have been reviewed and approved. NDE shall be performed before the pressure and leakage testing of the piping. Weld acceptance standards shall be in accordance with ASME B31.1, Chapter VI. If a weld fails the NDE, it shall be repaired and the test repeated at no additional cost to the Owner.

3-5. PROTECTIVE COATING. Standard weight steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating.

Where specified in the Miscellaneous Steel Pipe, Tubing, and Accessories section, extra strong steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating or a shop applied tape wrap. Where not specified to be shop coated or wrapped in the Miscellaneous Steel Pipe, Tubing and Accessories section, a tape wrap shall be field applied. The exterior surfaces of all fittings, couplings, specials, and other portions of buried piping not protected with plastic coating shall be tape-wrapped in the field.

All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils [1.5 mm]. Joints in plastic-coated pipe shall be cleaned, primed, and tape-wrapped after installation.

Joints in galvanized steel piping in underground locations shall be field painted with two coats of coal tar epoxy coating.

3-5.01. Inspection. All shop-applied plastic coatings and tape wrap on pipe or fittings shall be inspected for holidays and other defects after receipt of the pipe or fitting on the job and immediately before installation. All field-applied tape wrap on pipe, joints, fittings, and valves shall be inspected for holidays and other defects following completion of wrapping. Inspection of plastic coatings after installation of the pipe or fitting in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged during installation. Holidays and defects disclosed by inspection shall be repaired in accordance with the recommendations of the coating or tape wrap manufacturer, as applicable.

The inspection shall be made using an electrical holiday detector. The detector and inspection procedures shall conform to the requirements of Section 4.4 of ANSI/AWWA C209.

3-6. PRESSURE AND LEAKAGE TESTING. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. The Contractor shall coordinate this section with the Pipeline Pressure and Leakage Testing section. Piping shall be tested at the indicated pressures:

Service	Test Pressure	Test Medium
Water supply	1-1/2 times working pressure but not less than 120 psi [828 kPa]	Water
Gas supply	1-1/2 times working pressure but not less than 60 psi [414 kPa]	Compressed air
Air supply and signal (See paragraph 3-6.01)	1-1/2 times working pressure but not less than 50 psi [345 kPa]	Compressed air with 100 percent of all oil 0.025 micron and larger removed
Other piping	1-1/2 times working pressure but not less than 50 psi [345 kPa]	Suitable fluid or gas; for distilled water piping, distilled water or filtered oil-free compressed air may be used

Compressed air or pressurized gas shall not be used for testing plastic piping unless specifically recommended by the pipe manufacturer.

Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or other positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped as needed during the testing.

Unless otherwise required by the applicable codes, drainage and venting systems shall be air tested. For water testing, the drainage and venting system shall be filled with water to the level of the highest vent stack. For air testing, the system shall be charged with air to a minimum pressure of 5 psig [35 kPa]. Openings shall be plugged as necessary for either type of test. To be considered free of leaks, the system shall hold the water or air for 30 minutes without any drop in the water level or air pressure.

All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor. Contractor shall give Engineer 5 working days advanced notice of scheduled testing.

All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.

3-6.01. Air Pressure Tests. Pressure tests shall be performed on all air piping systems as specified herein.

Air piping shall be pressure tested in 3 steps. The first step shall be to pressurize the air piping to approximately 1/3 of the final test pressure and held for one hour. Then the pressure in the piping shall be increased to 2/3 of the final test pressure and held for one hour. Finally, piping shall be pressurized to the final test pressure, as specified herein, and again held for one hour. Piping shall hold pressure with minimal leakage to the satisfaction of Engineer before going to the next step.

Contractor shall be responsible for ensuring that all air piping is free of leaks. All joints which are found to be leaking shall be repaired and the test repeated.

3-7. CLEANING. The interior of all pipe, valves, and fittings shall be smooth, clean, and free of blisters, loose mill scale, sand, dirt, and other foreign matter when installed. Before being placed in service, the interior of all lines shall be thoroughly cleaned, to the satisfaction of Engineer.

Metal anhydrous ammonia, chlorine and sulfur dioxide piping shall be cleaned as recommended by the gas chemical feed system supplier. All surfaces which may come into contact with gas chemical shall be thoroughly dry and free of oil or grease before being placed in service. The recommended cleaning procedures shall be submitted for review in accordance with the Submittals section.

Tin-lined copper tubing for distribution of distilled water shall be flushed and cleaned with distilled water in accordance with the tubing manufacturer's recommendations.

3-8. ACCEPTANCE. Owner reserves the right to have any section of the piping system which he suspects may be faulty cut out of the system by Contractor for inspection and testing. Should the joint prove to be sound, Owner will reimburse Contractor on a time-and-material basis as specified in the Contract. Should the joint prove to be faulty, the destructive test will continue joint by joint in all directions until sound joints are found. Costs for replacement of faulty work and/or materials shall be the responsibility of Contractor.

End of Section

Section 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1-1. SCOPE. This section covers general mechanical building system requirements as referenced from other sections and furnishing and installation of:

Mechanical identification
Special coatings

for the plumbing and heating, ventilating, and air conditioning systems. Protective coatings for ductwork and equipment without special coatings shall be as specified in the Protective Coatings and Architectural Painting sections.

1-2. GENERAL. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by the Engineer.

1-2.01. Coordination. Where two or more units of the same class of materials are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

1-2.04. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete information, detailed specifications, and data covering materials, parts, devices, and accessories forming a part of the materials

furnished, shall be submitted in accordance with the Submittals Procedures section.

Number Plates
Product data on number plates.
A listing of equipment to receive number plates shall be submitted.
Special Coatings
Name of manufacturer.
Coating type.
Color.
Chemical resistance data.
Temperature range data.
Surface preparation.
Application data.
Film thickness per coat.
Drying and curing time information.
Equipment Motors
Name of Manufacturer.
Type and Model.
Horsepower (kW) rating and service factor.
Temperature rise and insulation rating.
Full load rotative speed.
Type of bearings and method of lubrication.
Net weight.
Overall dimensions.
Efficiency at full, 3/4, and 1/2 loads.
Full load current and power factor.
Locked rotor current.
Adjustable Frequency Drives
Type and model.
Name of manufacturer.
Operating speed range, rpm.
Rated bhp [kW] at maximum speed.
Efficiency at maximum speed, percent.
Maximum heat output, BTUH [kW].
Speed at maximum heat output, rpm.
Dimensions and net weight of complete panel.
Catalog and data sheets on all components.
Electrical schematics and wiring diagrams.

1-4. QUALITY ASSURANCE.

1-4.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate

records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1-4.02. Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section.

2-2.03. Equipment Efficiencies. Unless otherwise indicated in the respective equipment paragraph, the equipment efficiency shall be in accordance with the requirements of ASHRAE Energy Standard 90.1.

2-2.04. Drive Units. Drive units shall be designed for 24 hour continuous service.

2-2.04.01. V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable belt tension adjustment. V-belt drives shall have a service factor of at least 1.5 at maximum speed based on the nameplate horsepower [kW] of the drive motor unless otherwise indicated in the specific equipment paragraph. Multiple belts shall be provided in matched sets and shall be oil resistant, non-static type. External belts and drive assemblies shall be protected by a belt safety guard constructed in accordance with OSHA requirements. The guard shall be provided with a tachometer opening.

Unless otherwise indicated in the specific equipment paragraph, equipment with smaller than 10 horsepower [7.5 kW] motors shall have adjustable pitch sheaves and equipment with 10 horsepower [7.5 kW] and larger motors shall have fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as

necessary with sheaves of the proper size during the air system balancing to provide the required speed for the specified airflow.

2-2.04.02. Electric Motors for Building Mechanical Equipment. Motor horsepower scheduled on the Drawings are minimum motor horsepower. Larger motors shall be provided if required to meet the specified capacities for the equipment furnished. Motors furnished with equipment shall meet the following requirements.

a. Premium efficient motors with a minimum efficiency of at least that specified in the Common Motor Requirements for Process Equipment section shall be provided where available as a standard option. All other motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

b. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

c. Rated for continuous duty at 40°C ambient.

d. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet [1005 m], explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

e. To ensure long life, motors shall have nameplate horsepower [kW] equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp [kW]	Open	1.15
	Other Than Open	1.0
Integral hp [kW]	Open	1.15
	Other Than Open	1.0

Motors used with adjustable frequency drives shall have a 1.15 service factor on sine wave power and a 1.0 service factor on drive power.

f. Designed for full voltage starting.

g. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

h. Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

i. Bearings shall be either oil or grease lubricated.

j. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

k. Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

l. Totally enclosed motors shall be furnished on:

(1) Outdoor equipment.

(2) Equipment for installation below grade.

(3) Equipment operating in chemical feed and chemical handling locations.

(4) Equipment operating in wet or dust-laden locations.

m. Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

n. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, the motor types indicated are preferred and shall be furnished if offered by the manufacturer as a standard option.

o. Motors used with adjustable frequency drives shall have insulation system meeting the requirements of NEMA MG 1, Part 31.

2-2.05. Adjustable Frequency Drives. Adjustable frequency drives shall be provided as indicated on the Drawings and shall be coordinated with the requirements of the associated equipment. The equipment manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

Adjustable frequency drives shall be as covered in the Adjustable Frequency Drives section.

2-3. MANUFACTURE AND FABRICATION.

2-3.01. Welding. All welds shall be continuous (seal type) on submerged or partially

submerged components.

2-3.02. Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage in Concrete and Masonry section unless otherwise indicated on the Drawings.

2-3.03. Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2-3.04. Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2-4. MATERIALS.

2-4.01. Mechanical Identification. Mechanical identification consisting of equipment number plates, equipment information plates, valve tags, and ductwork identification shall conform to the requirements of the Equipment and Valve Identification section and as indicated herein.

2-4.01.01. Number Plates. Hand-lettered or tape labels will not be acceptable.

Number plates for control equipment such as but not limited to thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the specific device identification list the controlled equipment in parenthesis below the device number.

2-4.01.02. Piping. Piping identification shall be as specified in the Protective Coatings section. The lettering size, length of color field, colors, and viewing angles of identification devices shall be in accordance with ASME A13.1.

2-4.01.03. Valves. Valve tags shall indicate if the valve is normally open or normally closed.

2-4.01.04. Ductwork. Ductwork shall be identified with nameplates as specified herein, or stenciled painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

2-4.02. Seismic Design. Not used.

2-4.03. Special Coatings. Where indicated on the Drawings, sheet metal ductwork,

dampers, registers, grilles, coils, and equipment shall be given a special coating suitable for the corrosive atmosphere indicated. Sheet metal ductwork, dampers, registers, grilles, coils, and equipment construction shall be suitable to allow proper application of the special coating system in accordance with the manufacturer's recommendation.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by the Engineer.

The installation of identifying devices shall be coordinated with the application of covering materials and painting where devices are applied to surfaces. All surfaces to receive adhesive number plates shall be cleaned before installation of the identification device.

End of Section

Section 15060

MISCELLANEOUS PIPING AND PIPE ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of miscellaneous piping and pipe accessories. Miscellaneous piping shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

2.

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2-1. MATERIALS. Miscellaneous piping materials shall be as specified herein.

2-1.01. Material Classification BR-1. Not used.

2-1.02. Material Classification BR-2.

BR-2 – Extra Strong Brass Pipe	Pipe	ASTM B43, red brass, seamless, extra strong.

	Fittings ANSI/ASME B16.15Class 125.

2-1.03. Material Classification HS-1. Not used.

2-1.04. Material Classification HS-2. Not used.

2-1.05. Material Classification TG-1. Not used.

2-1.06. Material Classification CRP-1. Not used.

2-1.07. Accessories. Accessories for the miscellaneous piping systems shall be as indicated.

Unions for brass pipe Fed Spec A-A-59617, Class 125.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 15061

DUCTILE IRON PIPE

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of ductile iron pipe for all mechanical process service in the plant. Gravity sewer pipe is specified under Division 2, Section 02537. Ductile iron pipe shall be furnished complete with all fittings, specials, adapters, closure pieces, blowoffs, outlets, caps and plugs, temporary bulkheads, access manholes, jointing materials, pipe hangers and supports, anchors, blocking, encasement, appurtenances, and accessories specified and indicated on the Drawings, and as required for proper installation and functioning of the piping.

Piping furnished hereunder shall be complete with all joint gaskets, bolts, nuts and other jointing materials required for installation of any valves and equipment furnished by Owner or others for installation under this Contract.

Pipe hangers and supports, pressure and leakage testing, cathodic protection, and cleaning and disinfection are covered in other sections. Pipe trenching, embedment, and backfill are covered in the Trenching and Backfilling section.

1-1.01. Pipe Manufacturer's Experience and Field Services. All ductile iron pipe, fittings, specials, bolts, gaskets, other jointing materials, and appurtenances shall be fabricated, lined, coated, and furnished under the direction and management of one pipe manufacturer. The pipe manufacturer responsibilities, which shall include, at a minimum; coordinating and furnishing all pipe materials, gaskets, bolts, and other jointing materials, and pipe appurtenances (except for furnished coupled joints and other similar products by a specified manufacturer) for a complete piping system that meets the specified test pressures and service conditions; ensuring and certifying that all pipe, fittings, specials, and other pipe materials, pipe gaskets and bolts specified herein, are being manufactured in full accordance with the Contract Documents; preparing and submitting all submittal information and shop drawings; and making any corrections that may be required to submittal information and shop drawings.

The pipe manufacturer's minimum required experience qualifications shall include manufacture of interior and buried plant piping of similar diameters of at least two water or wastewater plants with joints, linings, and coatings suitable for the same or higher pressure rating, a pipeline at least 1 mile [1.6 km] in length, of a diameter equal to or larger than the pipe to be provided, with joints, lining, and coating suitable for the same or higher pressure rating, which has performed satisfactorily for the past 5 years.

All ductile iron pipe shall be installed in accordance with the pipe manufacturer's recommendations.

Certification by manufacturer for each item furnished in accordance with the ANSI/AWWA Standards.

Restrained joints details.

Emergency Repair Manual, including names and telephone numbers of emergency contact persons.

Certification of gaskets by pipe manufacturer, certifying that gasket material is suitable for test pressures and services intended.

Certification of joint lubricant.

Certification of proof-of-design tests for joints, including restrained joints.

Certification of pipe manufacturer or fabricator and certification of proof-of-design tests for welded-on outlets.

Pipe laying schedule complete with a sequence of laying and an explanation of all abbreviations used in the schedule. For long, straight pipe runs, the pipe laying schedule shall list the pipeline station and either the pipe centerline or invert elevation coordinated with the Drawings at least every 100 feet [30 m].

Two samples of the polyethylene encasement, each sample clearly identified as required by the Governing Standards and test results from an independent third party laboratory of the requirements specified in ANSI/AWWA C105/A21.5.

The method that the Contractor proposes to use for measuring deflection of pipe joints.

Submittal data shall clearly indicate the country of origin of pipe, fittings, flanges, restraining devices, and accessories. Certified copies of physical and chemical test results as outlined in ANSI/AWWA C151/A21.51 shall be submitted for the materials to be provided.

1-2.01. Emergency Repair Manual. Contractor shall submit an emergency repair manual prepared and furnished by the pipe manufacturer. The manual shall include procedures for handling emergency calls and repairs; a list of stock replacement pipe sections, closures, and other parts needed for emergency repairs; names and emergency telephone numbers of pipe manufacturer's engineering staff and factory-trained field service representatives who can be contacted day or night during an emergency; response and delivery times; and installation instructions for the materials and methods used in making repairs.

1-2.02. Pre-Submittal Meeting. Prior to the initial pipe submittal, a pre-submittal meeting will be held at a mutually agreed time and place. The meeting shall be attended by:

Representatives of Owner.

Contractor and Contractor's superintendent.

Contractor's pipe manufacturer's design engineer.

Representatives of Engineers.

Contractor shall bring to the meeting a preliminary schedule for the following:

Pipe installation sequencing.

Pipe fabrication and delivery.

Pipe shop drawings and data submittals as set forth in the Submittals Procedures section.

The purpose of the meeting is to review the preliminary schedules and submittal data requirements, to discuss the fabrication and delivery schedules, to review development of the pipe manufacturer's pipe laying schedule, and to establish procedure and coordinate efforts associated with the pipe submittals.

1-3. SHIPPING, HANDLING, AND STORAGE. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section, and as specified herein.

Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes or other abrasive tools shall not be permitted to come into contact with polyethylene lining if such lining is specified.
Contractor-furnished pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired.
If the lining of Owner-furnished pipe or fittings is damaged by Contractor during unloading or handling, the damaged pipe or fittings shall be replaced by and at the expense of Contractor. Where the damaged areas are small and readily accessible, Contractor may be permitted to repair the lining.

Contractor shall repair any damage to pipe coatings and linings before the pipe is installed.

PART 2 – PRODUCTS

2-1. PIPE CLASS. The class of ductile iron pipe shall be as indicated in the following table for those services indicated in the Pipeline Schedule section. The specified class includes service allowance and casting allowance.

Pipe Size		ANSI/AWWA Pressure Class
inches	mm	
64 thru 14	1600 thru 350	250
12 and smaller	300 and smaller	350

Pipe wall thickness for grooved and threaded end pipe shall be increased if necessary to comply with the following minimum thickness:

Pipe Size		Minimum Thickness Class	
inches	mm	Threaded Ends (1)	Grooved Ends (2)
4-16	100-400	53	53
18	450	53	54
20	500	53	55
24	600	53	56
30-54	750-1400	53	--
60 & 64	1500-1600	350 (3)	--

(1) Complies with ANSI/AWWA C115/A21.15 for minimum pipe wall thickness for threaded flanges.

(2) Complies with ANSI/AWWA C606 for grooved and shouldered joint ductile iron pipe.

(3) Minimum class for 60 and 64 inch pipe is pressure class 350.

2-2. MATERIALS.

Pipe	Ductile iron, ANSI/AWWA C151/A21.51, Table 1 or Table 3.

Gaskets – All Joint Types	Synthetic rubber unless otherwise specified; natural rubber will not be acceptable. All gaskets shall be furnished by the pipe manufacturer unless another manufacturer's product is indicated. Pipe manufacturer shall submit certificates of gasket suitability certifying that the gasket materials are compatible with the joints specified, are recommended for the specified field test pressure and service conditions. Gaskets for treated or potable water service shall be certified for chlorinated and chloraminated potable water. Gas and oil-resistant gaskets shall be made of Nitrile (NBR [Acrylonitrile Butadiene]) rubber. The name of the material shall be permanently marked or molded on the gasket. Gaskets shall also be certified as suitable where soils may be contaminated with gas and oil products.
Joint Lubricant	Vegetable-based lubricant recommended by the pipe manufacturer. Petroleum or animal-based lubricants will not be acceptable. Lubricants that will be in contact with treated or potable water shall be certified as being in compliance with ANSI/NSF 61.
Fittings	ANSI/AWWA C110/A21.10 (except shorter laying lengths will be acceptable for U.S. Pipe), or ANSI/AWWA C153/A21.53, minimum working pressure rating as follows, unless indicated otherwise on the Drawings.

Fitting Size in. [mm]	Material	Type	Min. Working Pressure Rating, psi [kPa]

4 to 24 [100 to 600]	DI	Mechanical and Push-on joints	350 [2,400]
4 to 24 [100 to 600]	DI	Flanged joints	250 [1,700]
30 to 48 [750 to 1,200]	DI	All joints	250 [1,700]
54 to 64 [1,350 to 1,600]	DI	All joints	150 [1,000]

All fittings shall be ductile iron and suitable for a factory test pressure of rated working pressure plus 100 psi [700 kPa] or 1.5 times rated working pressure, whichever is less, without leakage or damage.

Push-on Joints	ANSI/AWWA C111/A21.11.
Restrained Push-on Joints, gaskets with stainless steel gripping segments, (4 inch through 12 inch) [100 mm through 300 mm]	American “Fast Grip” or "Field Lok 350 Gasket" manufactured by U.S. Pipe and furnished to licensed Tyton® joint manufacturer.
Restrained Push-on Joints, locking wedge type, (4 inch through 24 inch) [100 mm through 600 mm]	EBAA Iron "Megalug" Series 1700; U.S. Pipe “TR Flex Gripper Ring”; Star Pipe Products “StarGrip 3100”; or American “Field Flex Ring”, without exception.
Restrained Push-on Joints, positive locking segments and/or rings, (4 inch through 36 inch) [100 mm through 900 mm]	American "Flex-Ring," or "Lok-Ring"; Clow "Super-Lock"; U.S. Pipe "TR Flex" or “HP Lok”; or Griffin "Snap-Lok."
Restrained Push-on Joints, positive locking segments and/or rings, (42 inch through 60 inch) [1000 mm through 1500 mm]	American "Flex-Ring," or "Lok-Ring"; Clow "Super-Lock"; U.S. Pipe "TR Flex"; or Griffin "Snap-Lok."
Restrained Push-on Joints, positive locking segments and/or rings, (64 inch) [1600 mm]	American "Flex-Ring," or "Lok Ring"; Clow "Super Lock"; or Griffin "Snap Lok."
Flanged Joints	ANSI/AWWA C115/A21.15.
Flanges	

Class 250 (Where identified on the Drawings)	Ductile iron, flat faced, with ANSI/ASME B16.1, Class 250 diameter and drilling.
All Others	Ductile iron, Class 125, ANSI/AWWA C115/A21.15.
Flanges	All flanges shall be suitable for test pressure of 1.5 times rated pressure without leakage or damage.
Bolts	ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch [6.3 to 12.7 mm] beyond outer face of nut.
Nuts	ASTM A563, hexagonal, ANSI/ASME B18.2.2, heavy semifinished pattern.
Gaskets	ASTM D1330, Grade I rubber, full face type, 1/8 inch [3 mm] thick unless otherwise required by pipe manufacturer and accepted by Engineer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.

Insulated Flanges

Flanges	As specified herein, except bolt holes shall be enlarged as needed to accept bolt insulating sleeves.
Insulation Kits	As manufactured by Advanced Products or Pipeline Seal and Insulator, Inc.
Insulating Gaskets	Type E, G-10, 1/8 inch [3 mm] thick, with Nitrile or EPDM sealing element for water and air service and Viton sealing elements for wastewater service unless otherwise required by pipe manufacturer and accepted by Engineer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Bolt Insulating Sleeves	G-10, 1/32 inch [0.79 mm] thick.

Insulating Washers	G-10, 1/8 inch [3 mm] thick, two for each flange bolt.
Backing Washers	Steel, 1/8 inch [3 mm] thick, two for each flange bolt.
Mechanical Joints	ANSI/AWWA C111/A21.11., with ductile iron glands.
Restrained Mechanical Joints (factory prepared spigot), (4 inch through 48 inch) [100 mm through 1,200 mm]	American "MJ coupled Joints", or Griffin "Mech-Lok".
Restrained Mechanical Joints, (field cut spigot), (4 inch through 24 inch) [100 mm through 600 mm]	EBAA Iron "Megalug" Series 1100, Sigma “One Lok” SLDE series, or Star Pipe Products “StarGrip 3000” without exception.
Wall Pipes or Castings	Mechanical joint with water stop and tapped holes; single casting or fabricated ductile iron pipe; holes sized in accordance with the details on the Drawings and provided with removable plugs.
Mechanical Joints with Tie Rods	As indicated on the Drawings.
Tie Rods	ASTM A307.
Steel Pipe	ASTM A53, Schedule 40 or 80 as indicated on the Drawings.
Washers	ANSI/ASME B18.22.1, plain steel.
Threaded Connections	ANSI/ASME B1.20.1, NPT; with boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4-thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.
Mechanical Couplings	
Couplings	Dresser "Style 38"; Smith-Blair "411 Steel Coupling"; or Romac “Style 400” or "Style 501"; without pipe stop.

Gaskets	Oil-resistant synthetic rubber gaskets shall be as recommended by the coupling manufacturer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Restrained Mechanical Couplings	American Pipe “Restrained Coupling Gland Joint” coordinated with mechanical couplings furnished.
Grooved-End Joints	AWWA C606.
Pipe Ends (rigid joints)	Grooved, with dimensions conforming to AWWA C606, Table 3.
Pipe Ends (flexible joints)	Shouldered, with dimensions conforming to AWWA C606, Table 4.
Couplings (non-shouldered pipe)	Tyco/Grinnell "Figure 772," or Victaulic "Style 31."
Couplings (shouldered pipe)	Victaulic "Style 41" or "Style 44".
Flanged Coupling Adapters	
Restrained (4 inch through 12 inch) [100 mm through 300 mm]. Unless otherwise indicated on the Drawings, flanged coupling adapters shall be restrained.	Smith-Blair "Type 912" or Romac "Style FCA501", with anchor studs of sufficient size and number to withstand test pressures.
Unrestrained (14 inch and larger) [350 mm and larger]	Smith-Blair "Type 913" or Romac "Style FC400".
Dismantling Joints	
Restrained (3 inch and larger) [75 mm and larger] Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.	Romac "DJ400"; Dresser "Style 131 Dismantling Joint" or Viking Johnson. For use in potable water systems, coating to be in accordance with NSF-61.
Tapping Saddles	Ductile iron, with stainless steel straps and synthetic rubber sealing gasket, 250 psi [1,700 kPa] pressure rating.

Watertight/Dusttight Pipe Sleeves	PSI "Thunderline Link-Seal", insulating type with modular rubber sealing elements, nonmetallic pressure plates, and stainless steel bolts and nuts.
Shop Coating and Lining	
Double Cement Mortar Lining with Seal Coat	ANSI/AWWA C104/A21.4.
Protective Fusion-Bonded	ANSI/AWWA C116/A21.16.
Ceramic Epoxy Lining	Induron "Protecto 401 Ceramic Epoxy".
Glass Lining	Two-coat system applied over blast-cleaned surface; ground and finish coats separately fired; finished lining thickness at least 10 mils [200 µm], Mohs' Hardness 5 to 6 density [2,500 to 3,000 kg/m^3] as determined by ASTM D792; Fast Fabricators, Inc. "MEH 32" or "SG-14".
Universal Primer	Manufacturer's standard. If in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61.
Asphaltic Coating	Manufacturer's standard.
Coal Tar Epoxy	Manufacturer's standard.
Liquid Epoxy	ANSI/AWWA C210, non-coal tar modified, or when in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Bostik/Never-Seez "Pure Nickel Special" or Permatex "Nickel Anti-Seize".
Corrosion Protection	
Polyethylene Encasement	Seamless, ANSI/AWWA C105/A21.5; LLDPE - 8 mil [200 µm] or HDCLPE - 4 mil [100 µm].

Heat-shrinkable Coating and Primer (Shrink Sleeve)	ANIS/AWWA C216, cross-linked polyethylene sheeting precoated with adhesive; minimum 80 mils; type and recovery as recommended by Shrink Sleeve manufacturer; Canusa-CPS or Coralenca Adhesives/Rachem Water Wrap.
Wax Tape and Primer	ANSI/AWWA C217, cold-applied petroleum wax primer and cold-applied petroleum wax tape; Trenton Wax-Tape and Primer.
Medium Consistency Coal Tar	Carboline "Bitumastic 50" or Tnemec "46-465 H.B. Tnemecol."

2-3. SHOP COATING AND LINING. The interior of all pipe and fittings, unless noted otherwise, shall be cement mortar lined and seal coated.

Lining for pipe and fittings for gravity sewers and wastewater facilities services shall be as specified below:

Service	Lining
Gravity sewers	Cement mortar.
Grit piping	Glass.
Scum piping	Glass.
All sludge piping except piping conveying activated sludge from final settling basins	Glass.
Sludge holding tank overflow and supernatant drawoff piping	Glass.
All other wastewater piping	Cement mortar.

Glass-lined pipe buried or embedded in concrete shall be ductile iron with mechanical or push-on joints; glass-lined pipe installed in interior locations may be flanged ductile iron with flanged cast or ductile iron fittings.

The exterior surfaces of all pipe and fittings which will be exposed in both interior and exterior locations shall be shop primed. Flange faces shall be coated with a suitable rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.

PART 3 - EXECUTION

3-1. INSPECTION. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; pipe ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site.

3-2. PROTECTION AND CLEANING. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign material prior to installation and shall be kept clean until the work is completed. Before jointing, all joint contact surfaces shall be wire brushed if necessary and wiped clean.

Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.

3-3. CUTTING PIPE. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or a power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.

All field cutting of existing gray cast iron pipe shall be done with mechanical pipe cutters, except where the use of mechanical cutters would be difficult or impracticable.

Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be acceptable. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be acceptable.

Contractor shall use factory prepared pipe ends unless a field cut is required for connections.

3-4. ALIGNMENT AND GRADE. Buried piping shall be laid to the lines and grades indicated on the Drawings and as specified. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the values stipulated for full-length push-on joint pipe for full-length mechanical joint pipe of AWWA C600, unless specially designed bells and spigots are provided. Contractor shall submit his proposed methods to measure deflection of deflected joints in accordance with the Submittal section.

Whenever deflections would exceed the values stipulated in AWWA C600, either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the Drawings and as acceptable to the Engineer.

Unless otherwise specified or acceptable to Engineer, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

Additional requirements for alignment and grade are covered in the Project Requirements and Trenching and Backfilling sections and on the Drawings.

3-4.01. Tolerances. Each section of pipe shall be laid to the alignment and grade indicated on the Drawings and pipe laying schedule with pipe ends within the following tolerances;

+/- 0.10 foot in grade at any point
+/- 0.20 foot in alignment at any point

In addition, piping shall be visually straight or on a smooth curve between the points of defection or curvature indicated on the Drawings. Stricter tolerances than specified above shall be used as necessary to maintain minimum cover, to maintain required clearances, to make connections to existing pipe, to maintain the correct slope to avoid high or low points along the pipeline other than at locations indicated on the Drawings, or to meet other restrictions as required or directed by the Engineer.

3-5. LAYING PIPE. Buried pipe shall be protected from lateral displacement by placing the specified pipe embedment material installed as specified in the Trenching and Backfilling section. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions.

Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug. All water in the trench shall be removed prior to removing the plug.

Pipe shall be laid with the bell ends facing the direction of laying, except where reverse laying is specifically acceptable by Engineer.
The pipe laying schedule shall be annotated during the progress of the work to show all changes made during construction for record documentation. Upon completion of the installation of the piping, the annotated pipe laying schedule shall be submitted to Engineer in accordance with the Submittals Procedures section.

3-6. FIELD JOINTS. Joints in buried and tunnel locations shall be mechanical or push-on type unless otherwise indicated on the Drawings or where required to connect to existing piping or to valves. Bells on wall castings and wall sleeves shall be mechanical

joint type, with tapped holes for tie rods or stud bolts. All other joints shall be flanged unless otherwise indicated on the Drawings.

Certification of joint design shall be provided in accordance with ANSI/AWWA C111/A21.11, Section 4.7, Performance Requirements, as modified herein. The joint test pressure shall be not less than 2 times the working pressure or 1-1/2 times the test pressure of the pipeline, whichever is higher. The same certification and testing shall also be provided for restrained joints. For restrained joints, the piping shall not be blocked to prevent separation and the joint shall not leak or show evidence of failure. It is not necessary that such tests be made on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design.

Each joint, including restrained joints, shall be checked by Contractor as recommended by the pipe manufacturer to verify that the joint and the restraints are installed properly. Restrained joints shall be extended after they are assembled to minimize further take-up.

Field closure pieces shall be located away from the bends beyond the length over which joints are to be restrained.
Where acceptable to Engineer, grooved couplings may be used instead of flanges, provided that rigid grooving is used to preclude longitudinal pipe movement and angular deflection at joints. Fittings, valves, and equipment installed using grooved couplings shall be adequately supported and blocked or restrained to prevent rotation.

3-7. MECHANICAL JOINTS. Mechanical joints shall be carefully assembled in accordance with the pipe manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Over tightening of bolts to compensate for poor installation practice will not be acceptable.
The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top centerline for horizontal piping.

3-8. PUSH-ON JOINTS. The pipe manufacturer's instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with a soap solution provided by the pipe manufacturer immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer's recommendations.

3-9. FLANGED JOINTS. Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.

When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually in a crisscross pattern and at a uniform rate, to ensure uniform compression of the gasket around the entire flange. All flange joint bolting procedures shall be in accordance with the pipe manufacturer's recommendations.

Special care shall be taken when connecting piping to any pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported to obtain accurate matching of bolt holes and uniform contact over the entire surface of flanges before any bolts are installed in the flanges.

Pump connection piping shall be free to move parallel to its longitudinal centerline while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe, so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping.

After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts shall then be loosened and the process repeated until no movement is observed.

3-10. FLANGED COUPLING ADAPTERS. Flanged coupling adapters shall be provided for restrained couplings 12 inch and smaller where indicated on the Drawings and as specified herein. Flange coupling adapters shall be installed in accordance with the coupling manufacturer's recommendations. After the pipe is in place and bolted tight, the locations of holes for the anchor studs shall be determined and the pipe shall be field-drilled. Holes for anchor studs shall be drilled completely through the pipe wall. Hole diameter shall be not more than 1/8 inch [3 mm] larger than the diameter of the stud projection. Unless indicated on the Drawings, all flange coupling adapters shall be restrained.

Unless indicated otherwise on the Drawings, all flange coupling adapters 12 inch and smaller shall be restrained. Flange coupling adapters 14 inch and larger may only be used in unrestrained pipe applications.

The inner and outer surfaces of couplings, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.

3-11. DISMANTLING JOINTS. Dismantling joints shall be provided for restrained couplings 6 inch and larger piping where indicated on the Drawings and as specified herein. Dismantling joints shall comply with AWWA C219 and shall be restrained flange by flange couplings manufactured as a single unit. Dismantling joints shall be installed in accordance with the coupling manufacturer's recommendations. Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.

The inner and outer surfaces of dismantling joints, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.

3-12. MECHANICAL COUPLINGS. Mechanical couplings shall be installed in accordance with the coupling manufacturer's recommendations. A space of at least 1/4 inch [6 mm], but not more than 1 inch [25 mm], shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

All surfaces, including the interior surfaces of the middle rings, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210.

3-12.01. Restrained Mechanical Couplings. Pipe restraining glands with tie bolts shall be provided to restrain mechanical coupling connections where indicated on the Drawings. The connecting pipe shall be furnished with welded retainer rings as recommended by pipe manufacturer. The pipe manufacturer shall also coordinate the restrained connection with the pressure rating, length, and diameter dimensions of the mechanical coupling being furnished to assure proper clearance is provided for completing the restrained coupling installation.

3-13. GROOVED-END JOINTS. Grooved-end joints with rigid type grooving shall be installed in accordance with the coupling manufacturer's recommendations. Completed

joints shall be rigid and shall allow no angular deflection or longitudinal movement. Except for closure pieces, field grooving of pipe will not be acceptable.

Grooved-end couplings shall not be used in the following applications: chemical service, except lime slurry piping, flammable liquid or flammable gas piping, compressed air or compressed gas piping operating at pressures above 25 psig [170kPa], toxic gas piping, hot liquid with operating temperatures above 120°F [48°C], or steam piping.

3-14. GAS AND OIL-RESISTANT GASKETS. Gas and oil-resistant gaskets shall be installed where specified, indicated on the Drawings, or directed by Engineer where jointing gaskets may be subject to permeation when piping passes through areas where soil may be contaminated with gas or petroleum (oil) products or organic solvents or their vapors.

3-15. CORROSION PROTECTION.

3-15.01. Polyethylene Encasement. All buried pipe including all straight pipe, bends, tees, adapters, closure pieces, and other fittings or specials, shall be provided with at least one wrap of polyethylene encasement. Other locations where ductile iron pipe and accessories shall be double wrapped with polyethylene encasement shall be as specified herein and as indicated on the Drawings. Where ductile iron pipe is also embedded or encased in concrete the polyethylene encasement shall be installed around the pipe for 5 feet [1.5 m] extending into each end of the concrete encasement.

All buried flanged valves, mechanical joint couplings with tie rods, mechanical couplings, restrained mechanical couplings and other pipe harness assemblies at valves or structure walls shall be provided with two wraps of polyethylene encasement in addition to other corrosion protection coatings as specified herein.

Polyethylene tube protection shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Preparation of the pipe shall include, but shall not be limited to, removal of lumps of clay, mud, cinders, etc., prior to installation.

The terms "polyethylene tube protection" and "polyethylene encasement" are interchangeable and shall have the same meaning in these Contract Documents.

3-15.01.01. Inspection and Testing. Tests for preliminary acceptance of polyethylene encasement materials as required in the submittal paragraph shall be made at the expense of the Contractor.

At the Owner's expense, the Owner may obtain samples from the material supplied in the field and have test conducted of the requirements specified in ANSI/AWWA C105/A21.5 by an independent third-party laboratory,

3-15.02. Mechanical Joint Couplings with Tie Rods. The mechanical joint tie rods, bolt studs, pipe spacers and washers of buried mechanical joint couplings shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

Following application of the wax tape protection, the entire mechanical joint coupling assembly shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the coupling assembly.

3-15.03. Flanged Valves. The flange bolts and nuts on buried flanged valves shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

Following application of the wax tape protection, the entire valve, including the bottom housing and the actuator to the wrench nut, shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the valve.

3-15.04. Mechanical Couplings. The tie bolts and nuts on all buried mechanical couplings shall be coated with two coats of medium consistency coal tar.

After the protective coating has been applied to the tie bolts, the entire mechanical coupling shall be encapsulated with a shrink sleeve . The shrink sleeve shall extend a minimum of 6 inches on to the pipe on each side of the coupling. A primer shall be applied to the piping on each side of the coupling prior to installing the shrink sleeve. The application of the shrink sleeve shall be in accordance with ANSI/AWWA C216 and as recommended by the shrink sleeve manufacturer. There shall be no bare or unprotected ferrous metal surfaces. Following installation of the shrink sleeve, the entire assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

3-15.05. Restrained Mechanical Couplings. The corrosion protection for the mechanical coupling and its tie bolts and nuts of all buried restrained mechanical coupling assemblies shall be protected with two coats of medium consistency coal tar and shrink sleeve as specified herein for buried mechanical couplings.

The tie rods and bolts of the restraining glands of the coupling assembly shall be protected by wrapping them with wax tap in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

Following the application of the wax tape, the entire restrained mechanical coupling assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

3-15.06. Other Assemblies. All ferrous metal clamps, tie rods, bolts, and other components of buried joint harnesses, tapping saddles, or pipe reaction anchorages in contact with earth or other fill material and not encased in concrete, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

Following the application of the wax tape, the entire assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

3-15.07. Surfaces Exposed in Manholes and Vaults. Unless otherwise specified, all uncoated surfaces exposed in manholes and vaults shall be cleaned and coated with two coats of medium consistency coal tar. The first coat shall be dry and hard before the second coat is applied. There shall be no unprotected, bare, or uncoated ferrous metal surfaces.

3-15.08. Cathodic Protection Systems. Not used.

3-16. OUTLETS. Not used.

Where a flange and mechanical joint pipe piece is to connect to a mechanical joint wall pipe or casting, the bolt holes in the bell of the wall pipe or casting shall straddle the top centerline of the horizontal pipe or casting and shall align with the bolt holes in the flange and mechanical joint piece. The top centerline shall be marked on the wall pipe or casting at the foundry or fabrication shop.

In vertical piping, the bolt holes of flanged and mechanical joint floor pipes or castings shall be aligned with the bolt holes of the flange or mechanical joint connecting piece. The required centerline alignment and orientation of the floor pipe or casting shall be marked on the floor pipe or casting at the foundry or fabrication shop.

3-18. WALL AND FLOOR SLEEVES. Wall and floor sleeves shall be installed where indicated on the Drawings and shall be installed where ductile iron pipe passes through concrete walls and floors or masonry walls, unless otherwise noted. To minimize sleeve size, piping on either side of the sleeve shall be provided with a screw-on flange, grooved coupling, or mechanical coupling with anchor studs to allow the pipe to pass through the sleeve. Where required, sleeves in masonry walls may be enlarged enough for flange or other joint restraint to pass through the sleeve.

Where specified or indicated on the Drawings, one or two sets of modular casing seals shall be installed at the face of walls to seal against soil or provide a dust or water tight seal. Contractor shall coordinate the diameter of wall or floor sleeves with the modular casing seal manufacturer. When soil may be present at wall sleeves, two sets of modular casing seals shall be installed, one at each face of the wall. Unless otherwise indicated on the Drawings, modular casing seals shall not be used in submerged conditions unless the hydrostatic pressure is less than 20 feet and piping is less than 24 inch size.

3-19. REDUCERS. Reducers shall be eccentric or concentric as indicated on the Drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

3-20. BLOWOFFS. Each blowoff shall be located and arranged as indicated on the Drawings.

3.21. ACCESS OPENINGS. Not used.

3-22. CONNECTIONS WITH EXISTING PIPING. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from dewatered lines and excavations without damage to adjacent property.

Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then all connections with potable water pipelines shall be cleaned and disinfected as specified in the Cleaning and Disinfection of Water Pipelines section.

3-23. INSULATED FLANGED JOINTS. Insulated flanged joints shall be installed where indicated on the Drawings. In addition to one full-faced insulated gasket, each flange insulating assembly shall consist of one full-length sleeve, two insulating washers, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch [3 mm] less than the ID of the flange in which it is installed. The insulated

flanged joint accessories shall be installed in accordance with the instructions and recommendations of the insulating kit manufacturer.

3-24. CONCRETE ENCASEMENT. Not used.

The blocking size shall be of the dimensions indicated on the Drawings, shall extend from the fitting to solid, undisturbed earth, and shall be installed so that all joints are accessible for repair. If adequate support against undisturbed ground cannot be obtained, restrained joints shall be installed to provide the necessary support. If the lack of suitable solid vertical excavation face is due to improper trench excavation, restrained joints shall be furnished and installed by and at the expense of Contractor.

Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, installed above grade, or exposed within structures, shall be provided as indicated on the Drawings.

All ferrous metal clamps, rods, bolts, and other components of tapping saddles, reaction anchorages, or joint harness, subject to submergence or in contact with earth or other fill material and not encased in concrete, shall be protected from corrosion as specified in the Corrosion Protection paragraph of this section.

End of Section

Section 15065

MISCELLANEOUS STEEL PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of miscellaneous steel pipe, tubing and accessories that for pipe diameters 24 inches [600 mm] and smaller. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

Steel pipe for potable and non-potable water conveyance are covered in the Steel Pipe section.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

1-4.01. Coated Pipe. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2-1. GALVANIZED STEEL PIPE.
Galvanized steel pipe materials and service shall be as specified herein.

2-1.01. Material Classification CSG-1.

CSG-1 – Standard Weight Galvanized Steel with Threaded Fittings All pipe sleeves except where plastic sleeves are required.	Pipe Fittings	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized. Cast iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.4, Class 125.

2-1.02. Material Classification CSG-2.

CSG-2 – Standard Weight Galvanized Steel with Threaded Fittings Grease piping – pumping units. Sump pump discharge piping in interior locations except where buried. Filtrate piping. Drain piping from equipment.	Pipe Fittings	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized. Malleable iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type II.

2-1.03. Material Classification CSG-3.

CSG-3 – Standard Weight Galvanized Steel with Flanged Fittings. Sump pump discharge	Pipe Fittings	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized. Cast iron flanged, galvanized. Fittings shall conform to ANSI/ASME B16.1, Class 125.

piping in interior locations except where buried.	

2-1.04. Accessory Materials. Accessory materials for galvanized steel pipe shall be as indicated in the Steel Pipe section of the specification.

2-2. STEEL PIPE. Steel pipe materials and service shall be as specified herein.

2-2.01. Material Classification CS-1. Not used.

2-2.02. Material Classification CS-2.

CS-2 – Standard Weight Steel with Socket Welded Fittings. Natural or LP gas piping, buried or interior locations. Steam and condensate piping. Sodium hydroxide solution piping, interior locations or outdoors above grade. Heating water system piping. Chilled water system piping. Methanol piping. Compressed air supply piping, 2 inch [50 mm] and smaller up to 250 psig [1725 kPa gauge]. 2 inch [50 mm] and smaller.	Pipe Fittings	ASTM A53/A106, Type S, standard weight, Grade B; Plain ends. Forged steel socket welded. Fitting shall conform to ANSI B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.

2-2.03. Material Classification CS-3.

CS-3 – Standard Weight Steel with Buttwelded Fittings. Aeration air piping. Natural or LP gas piping, buried or interior locations. Steam and condensate piping. Sodium hydroxide solution piping, interior locations or outdoors above grade. Sodium hydroxide solution piping,	Pipe Fittings	ASTM A53/A106, Type S, standard weight Grade B; Bevel ends. Buttwelded. Fitting shall conform to ANSI/ASME B16.9, standard weight.

interior locations or outdoors above grade. Compressed air supply piping up to 250 psig [1725 kPa gauge]. Fuel oil or diesel fuel piping in interior locations or outdoors above grade. Heating water system piping. Chilled water system piping. Methanol piping. 2-1/2 inch [63 mm] and larger.	

2-2.04. Material Classification CS-4. Not used.

2-2.05. Material Classification CS-5. Not used.

2-2.06. Material Classification CS-6.

CS-6 – Extra Strong Steel with Buttwelded Fittings. Compressed air supply piping, 2-1/2 inches [63 mm] and larger, 251-500 psig [1730-3450 kPa gauge].	Pipe Fittings	ASTM A53, Type E, extra strong, Grade B; or ASTM A106, of equivalent thickness. Bevel ends. Buttwelded. Fittings shall conform to ANSI/ASME B16.9; extra strong.

2-2.07. Material Classification CS-7. Not used.

2-2.08. Material Classification CS-8. Not used.

2-2.09. Material Classification CS-9. Not used.

2-2.10. Material Classification CS-10. Not used.

2-2.11. Material Classification CS-11. Not used.

2-2.12. Material Classification CS-12. Not used.

2-2.13. Material Classification CS-13. Not used.

2-2.14. Material Classification CS-14. Not used.

2-2.15. Accessory Materials. Accessory materials for the miscellaneous steel pipe and tubing systems shall be as indicated.

Nipples	ASTM A733, seamless, extra strong (Schedule 80); "close" nipples will be permitted only by special authorization in each case.
Unions (Malleable Iron)	Fed Spec WW-U-53l, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe.
Flanges	
Standard Weight Pipe	ANSI/ASME B16.5, Class 150, flat faced when connected to flat faced flanges; otherwise, raised face.
Extra Strong Pipe	
Chemical Gas Piping	ASTM A105, forged steel, tongue and groove flanged union type, with nonmetallic gasket; rated for a working pressure of 1,500 psi [10.3 MPa].
Other services	ANSI/ASME B16.5, Class 300, raised face.
Plastic Lined Pipe	Steel, forged or cast, diameter and drilling in accordance with ANSI/ASME B16.5, Class 150 or 300 as required.
Flange Bolts and Nuts	ASTM A193, Grade B7 with ASTM A194 Grade 2H nuts. Length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut.
Flange Gaskets	
For Process Air Service	
Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch [1.5 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces, rated for 275°F [135°C] service; Garlock "IFG 5507".
Flat Faced Flanges	Premium Grade, EPDM, full face, 1/8 inch [3 mm] thick, rated for 275°F [135°C]

	service; Garlock "8314".
For Boiler Exhaust Service	Garlock "Blue-Gard, Style 3000".
For Oil Service	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch [1.5 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces.
For Heating Water Service	Non-asbestos inorganic fiber with nitrile binder; dimensions to suit flange contact face, 1/16 inch [1.5 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces; Garlock "IFG 5500".
For Water Service	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch [3 mm] thick.
For Chemical Service	Suitable for chemical.
For Other Services	
Flat Faced Flanges	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch [1.5 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces.
Raised Face Flanges	Continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch ±0.005 inch [2.4 mm ±0.13 mm].

Grooved Couplings

Rigid	AWWA C606; Gustin-Bacon "No. 120 Rigid" or Victaulic "07 Zero-Flex".
Standard	AWWA C606; Gustin-Bacon "No. 100 Standard" or Victaulic "Style 77".

Mechanical Couplings: Dresser "Style 38" or Smith-Blair "Type 411 Flexible Coupling"; without pipe stop.

Expansion Joints

Process air

Expansion joints shall be the elastomeric, arched type and shall be Mercer “Type 450” with “Type 500” retaining rings and Kevlar reinforcement, or equal.

The number of arches shall be as indicated on the Drawings. The connection shall be suitable for a maximum pressure of 15 psig [105 kPa gauge] and maximum temperature of 250 F [122 C]. Expansion joints shall have the following ratings:

Number of Arches:	1
Spring rate:	___ lbs/inch
Movement:	___ inch
Number of Arches:	2
Spring rate:	___ lbs/inch
Movement:	___ inch
Number of Arches:	3
Spring rate:	___ lbs/inch
Movement:	___ inch

Heating water, chilled water, and other services not specified.

Flexonics "Model H Expansion Compensators" for 3 inch [75 mm] or smaller; Flexonics "Mid-Corr, Series MCB" with flanged ends and stainless steel bellows for 4 inch [100 mm] or larger. Expansion joints shall be suitable for working pressures up to 150 psig [1035 kPa].

Material Classification

CS-14: Double wall pipe with leak detection.

Joining

Carrier pipe shall be joined by socket welding. Containment pipe shall be joined by split sleeve of the same diameter as containment pipe with minimum 60 mil [1.5 mm] thick polyethylene jacket.

End Seal

End seals shall be furnished at all terminal ends. The end seal shall be sealed to the containment pipe.

Leak Detection

Microprocessor based monitoring unit, for continuous monitoring by cable of a single line for water and hydrocarbon.

Control Panel

Modified NEMA Type 12 enclosure, with Status and Alarm Data Model "PAL-AT20C". Power supply to the unit will be 120 volt, 1 phase, 60 Hz. Unit shall be UL listed with alarm horn and shall locate leaks and not depend on battery back-up functions.

	System conditions shall be stored in memory in the event of power failure and shall automatically resume monitoring without reset once power is available. Monitoring unit shall be able to differentiate between water left in pipe during installation and an actual growing leak. Panel shall also be able to detect a break in sensor cable and its location.
Cable	Cable shall be located in the interstitial space between the carrier and containment pipe, shall detect both water and hydrocarbon, and shall be capable of being dried in place without being replaced after exposure to any fluid Type "AGW-Gold". Coaxial cable shall interface monitoring control panel with sensor cable by utilizing waterproof junction box for protecting connection.

2-3. COATINGS. Standard weight steel pipe in buried locations, except hot piping such as aeration air piping, shall have exterior surfaces protected with a shop applied plastic coating. Coatings for hot piping shall be as specified.

Extra strong steel pipe in buried locations shall have exterior surfaces protected with a shop applied plastic coating.

Shop applied coatings shall be as follows:

External Coatings

Plastic	Liberty Coating Company “Pritec" or Bredero-Shaw “Entec". The products of other manufacturers will not be acceptable.
Tape Wrap	ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils [760 µm]; Protecto Wrap "200" or Tapecoat "CT".
High temperature epoxy for aeration and process air piping	Shop or field applied high solids epoxy; suitable for protection at continuous pipe wall temperatures up to 300 F. Coating shall be abrasion resistant. The finished coating shall have a minimum total film thickness of 10 mils. The surface shall be prepared in

accordance with SSPC-SP7 as a minimum unless otherwise recommended by the coating manufacturer. The coating shall be Carboline “Thermaline 450”, Ameron “Amerlock 400 with Amercoat 880 Additive”, or approved equal.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 15067

MISCELLANEOUS PLASTIC PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of miscellaneous plastic pipe, tubing, and accessories. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, jointing materials and other necessary appurtenances.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

Pipe, tubing, and fittings shall be stored between 40°F and 90°F [4°C and 32°C].

PART 2 - PRODUCTS

2-1. FRP PIPE. FRP pipe materials and services shall be as specified herein.

2-1.01. Material Classification FRP-1.

FRP-1 – FRP Pipe Exhaust air service	Pipe	ASTM D2996, filament-wound, glass fiber reinforced, vinyl ester resin pipe with 20 mil [500 µm] reinforced resin-rich liner; Fibercast "F-Chem 1222" or Smith Fiberglass Products "Poly Thread".
	Fittings	Glass fiber reinforced, compatible with the specified pipe, with ratings and chemical resistance equal to or greater than the specified pipe.

2-1.02. Accessory Materials. Accessory materials for the FRP pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ASTM A307, Grade B, galvanized, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut.
Flat Washers	ANSI B18.22.1, plain, galvanized.
Flange Gaskets	Full face, 1/8 inch [3 mm] thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.

2-2. PVC PIPE MATERIALS. PVC pipe materials and services shall be as specified herein.

2-2.01. Material Classification PVC-1.

PVC-1 – Schedule 40 PVC Pipe with Solvent Welded Joints. Irrigation system supply mains and lateral piping.	Pipe	ASTM D1785, Cell Classification 12454, bearing NSF seal, Schedule 40.
	Fittings	ASTM D2466, Cell Classification 12454, bearing NSF seal.

2-2.02. Material Classification PVC-2.

PVC-2 – Schedule 80 PVC Pipe with Solvent Welded Joints.	Pipe	ASTM D1785, Cell Classification 12454, bearing NSF seal, Schedule 80. ASTM D2467, Cell Classification 12454, bearing NSF seal.
	Fittings	Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld. When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.

2-2.03. Material Classification PVC-3.

PVC-3 – Schedule 80 PVC Pipe with Threaded Joints. Swing joints in irrigation system piping.	Pipe	ASTM D1785, Cell Classification 12454, bearing NSF seal, Schedule 80.
	Fittings	ASTM D2464, Cell Classification 12454, bearing NSF seal.

2-2.04. Material Classification PVC-4.

PVC-4 – PVC DWV Pipe (Single Wall) with Solvent Welded Joints. Waste and vent piping for plumbing systems.	Pipe	ASTM D1785, cell classification 12454, bearing NSF seal.
	Fittings	ASTM D2665 and ASTM D3311, cell classification 12454, bearing NSF seal.

2-2.05. Material Classification PVC-5.

PVC-5 – PVC DWV Pipe (Double Wall Containment) with Solvent Welded Joints. Chemical resistant waste and vent piping for plumbing systems.	Pipe Fittings	George Fischer Sloane "+GF+Contain-It"; with manufacturer's standard spacers, fittings, and suitable chemical service solvent or equal. ASTM D2665 and ASTM D3311, cell classification 12454, bearing NSF seal.

2-2.06. Material Classification PVC-6. Not used.

PVC-6 – PVC Underdrain Pipe Drain piping	Pipe Fittings	ASTM F758, solid wall, Cell Classification 12454 or 12364, Type PS 46. ASTM D3034, Cell Classification 12454, wall thickness SDR 35, with elastomeric gasket joints.

2-2.07. Material Classification PVC-7. Not used.

2-2.08. Material Classification PVC-8. Not used.

2-2.09. Accessory Materials. Accessory materials for the PVC Pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150. Schedule 80 for DWV systems.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut. Stainless steel for DWV and chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain. Same material as bolts and nuts.
Flange Gaskets	Full face, 1/8 inch [3 mm] thick, chemical-resistant elastomeric material suitable for the specified service.

Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.

2-3. CPVC PIPE. CPVC pipe materials and services shall be as specified herein.

2-3.01. Material Classification CPVC-1.

CPVC-1 – Schedule 80 CPVC Pipe with Solvent Welded Joints.	Pipe	ASTM F441, Cell Classification 23447, bearing NSF seal, Schedule 80.
	Fittings	ASTM F439, Cell Classification 23447, bearing NSF seal.
Ferric chloride piping.		Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves.
Polymer and polymer solution piping.		Flanges or unions shall be joined to the pipe by a solvent weld.
Water piping.		When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.

2-3.02. Accessory Materials. Accessory materials for the CPVC Pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut.
	Stainless steel for chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain. Same material as bolts and nuts.
Flange Gaskets	Full face, 1/8 inch [3 mm] thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex

"Style R6905" molded expansion joint.

2-4. PE PIPE. PE pipe materials and services shall be as specified herein.

2-4.01. Material Classification PE-1.

PE-1 – Polyethylene Pipe with Socket Fusion Joints. Digester gas, buried. LP gas, buried. Natural gas, buried. 2 inch [50 mm] and smaller	Pipe Fittings	ASTM D3350, Cell Classification PE345464C. ASTM D2513, IPS, SDR11; CP Chem Performance Pipe Co. “Yellowstripe 8300”. ASTM D3350, Cell Classification PE 345464C. ASTM D2683, socket type, with wall thickness same as for pipe.

2-4.02. Material Classification PE-2.

PE-2 – Polyethylene Pipe with Butt Fusion Joints. Digester gas, buried. LP gas, buried. Natural gas, buried. 3 inch [75 mm] and larger	Pipe Fittings	ASTM D3350, Cell Classification PE345464C. ASTM D2513, IPS, SDR11; CP Chem Performance Pipe Co. “Yellowstripe 8300”. ASTM D3350, Cell Classification PE 345464C. ASTM D3261, butt heat fusion type, with wall thickness same as for pipe.

2-4.03. Material Classification PE-3.

PE-3 – Polyethylene Tubing with Compression Fittings. Chlorine gas, from vacuum regulator to injector.	Tubing Fittings	Polyethylene, 1/8 through 5/8 inch [3 through 16 mm] OD, 1/16 inch [1 mm] wall thickness, 130°F [54°C] max operating temperature. As recommended by the chlorine feed system manufacturer.

2-4.04. Material Classification PE-4.

PE-4 – Polyethylene Pipe.	Pipe	ASTM D3350, Cell Classification PE345464C or PE345464E. ASTM

Aqua ammonia solution piping, buried. Sodium hydroxide solution piping, buried or submerged.		F412, SDR-11, pressure rating Driscoplex "PE 3408". Molded or manufactured from pipe; cell classification of material and pressure rating same as for pipe.

2-4.05. Material Classification PE-5. Not used.

2-4.06. Material Classification PE-6. Not used.

2-4.07. Accessory Materials. Accessory materials for the PE Pipe systems shall be as indicated.

Flanges	Schedule 80 PVC; diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ANSI B18.2.1, ASTM A193, AISI Type 304, heavy hex head, length such that after installation the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut. ASTM A194, AISI Type, ANSI/ASME B18.2.2, heavy hex pattern.
Fittings and Flange Adapters	Molded or manufactured from the pipe; cell classification of material and pressure rating same as for pipe.

2-5. POLYPROPYLENE PIPE. Polypropylene pipe materials and services shall be as specified herein.

2-5.01. Material Classification PP-1.

PP-1 – Schedule 80 Polypropylene Pipe with Socket Fusion Joints. Distilled water. Deionized water.	Pipe Fittings	ASTM D4101, Class 1, virgin, unpigmented homopolymer without additives or UV stabilizer; Enfield or Orion, Schedule 80. Dimensions in accordance with ASTM D2447. Same material as pipe. Socket fusion type compatible with the pipe; Enfield or Orion.

2-5.02. Material Classification PP-2.

PP-2 – Schedule 40 Polypropylene DWV	Pipe	Schedule 40, ASTM D4101. Orion "Brownline" standard type where

Pipe with Heat Fused Joints. Chemical resistance waste and vent piping for plumbing systems.	 Fittings	buried and "Blueline" flame retardant type where abovegrade, Enfield, or R&G Sloan. Schedule 40, drainage pattern with manufacturers' standard heat fused socket joint. Solvent weld joints not permitted. Fittings and pipe shall be provided by the same manufacturer.

2-5.03. Material Classification PP-3.

PP-3 – Schedule 40 Polypropylene DWV Pipe with Mechanical Joints. Chemical resistance waste and vent piping for plumbing systems, above grade locations.	Pipe Fittings	Schedule 40, ASTM D4101. Orion "Blueline" for flame retardant type, Enfield, or R&G Sloan. Schedule 40, drainage pattern with manufacturers' standard mechanical joints. Fittings and pipe shall be provided by the same manufacturer.

2-6. PVDF PIPE. PVDF pipe materials and services shall be as specified herein.

2-6.01. Material Classification PVDF-1.

PVDF-1 – Schedule 40 PVDF DWV Pipe with Heat Fused Joints. Chemical resistance waste and vent piping for plumbing systems, in air plenums.	Pipe Fittings	Schedule 40, UL 94-VO, non-combustible. Orion or equal. Schedule 40, drainage pattern with manufacturers' standard heat fused socket joint. Solvent weld joints not permitted. Fittings and pipe shall be provided by the same manufacturer.

2-6.02. Material Classification PVDF-2.

PVDF-2 – Schedule 40 PVDF DWV Pipe with Mechanical Joints. Chemical resistance waste and vent piping for plumbing systems, in air plenums.	Pipe Fittings	Schedule 40, UL 94-VO, non-combustible. Orion or equal. Schedule 40, drainage pattern with manufacturers' standard mechanical joints. Fittings and pipe shall be provided by the same manufacturer.

2-6.03. Material Classification PVDF-3.

PVDF-3 – Schedule 80 PVDF Pipe with Heat Fused Joints. Sulfuric acid tank vent and overflow piping. Sulfuric acid solution piping, buried or submerged.	Pipe Fittings	ASTM D3222 for Type 1 homopolymers. Manufactured to wall thicknesses specified in ASTM D1785 for Schedule 80 Pipe. ASTM D2467. Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a heat fusion weld. When acceptable to the Engineer, threaded joints may be used instead of heat fused joints for the purpose of facilitating disassembly. The use of threaded joints in this system shall be held to a minimum.

2-6.04. Material Classification PVDF-4. Not used.

2-6.05. Accessory Materials. Accessory materials for the PVDF Pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150. Schedule 80 for DWV systems.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut. Stainless steel for DWV and chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain. Same material as bolts and nuts.
Flange Gaskets	Full face, 1/8 inch [3 mm] thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.

2-7. REINFORCED PLASTIC TUBING. Reinforced plastic tubing materials and services shall be as specified herein.

2-7.01. Material Classification RPT-1.

RPT-1 – Reinforced Plastic Tubing. Flexible connections in chemical piping 1/2 inch [13 mm] and smaller.	Tubing	Wire reinforced PVC hose; Cobon Plastics Corp. "Cobovin Type S" or NewAge Industries Inc. "Vardex".

2.8. FLEXIBLE PFA TUBING. Flexible PFA tubing materials and services shall be as specified herein.

2-8.01. Material Classification PFA-1. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 15069

CAST IRON SOIL PIPE AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of cast iron soil pipe and accessories for the service conditions as specified herein. Cast iron soil pipe shall be furnished complete with all fittings and other accessories.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Items requiring submittals shall include, but shall not be limited to, the following:

Pipe, Gaskets, and Couplings.
- Name of Manufacturer.
- Type and Model.
- Construction materials, thickness, and finishes.
- Coating product data sheets.
- Certification by manufacturer that the pipe and fittings furnished are in accordance with referenced standards. Certification shall include legal name and address of the manufacturer.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2-1. MATERIALS.

2-1.01. Product Marking. Pipe and fittings shall bear manufacturer's product marking as required by the referenced standards. Markings shall be plainly marked including but not limited to country of origin, manufacturer's name, and date of manufacturer.

2-1.02. Material Classification CI-1.

CI-1 – Bell and Spigot Building sanitary drain, waste, and vent piping, all locations. Building storm drain piping, all locations. Clear water waste piping, all locations	Pipe and Fittings Jointing Material	ASTM A74 Rubber gaskets, ASTM C564.

2-1.03. Material Classification CI-2.

CI-2 – Hubless Building sanitary drain, waste, and vent piping, all locations except where buried. Building storm drain piping, all locations except where buried. Clear water waste piping, all locations except where buried.	Pipe and Fittings Jointing Material	CISPI 301. Heavy duty coupling, with neoprene rubber sleeve, 304 stainless steel shield, and stainless steel clamping bands, or bolted cast iron coupling with stainless steel bolts and neoprene gasket. Couplings shall be Clamp-All Products “HI-TORQ 125”, Husky “SD 4000”, Mission Rubber Company LLC “HeavyWeight Coupling”, or MG Piping Products “MG Coupling”, without exception.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 15070

COPPER TUBING AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of copper tubing and accessories. Copper tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2-1. MATERIALS. Copper tubing materials and service shall be as specified herein.

2-1.01. Material Classification CU-1.

CU-1 – Water Tubing with Flared Fittings Buried water supply, 2 inch [50 mm] and	Tubing Fittings	Soft annealed copper tubing, ASTM B88, Type K. Flared, material to match tubing. Fittings shall conform to ANSI/ASME B16.26.

smaller.	

2-1.02. Material Classification CU-2.

CU-2 – Water Tubing with Brazed Joints Buried water supply, 2-1/2 and 3 inch [65 and 75 mm].	Tubing Fittings	Hard drawn copper tubing, ASTM B88, Type K. Brazed joint, material to match tubing. Fittings shall conform to ANSI B16.18 or ANSI/ASME B16.22.

2-1.03. Material Classification CU-3.

CU-3 – Water Tubing with Solder and Brazed Joints Potable and non-potable, water supply, 3 inch [75 mm] and smaller. Hot water supply.	Tubing Fittings Flanges	Hard drawn copper tubing, ASTM B88, Type L. Solder joint (smaller than 2 inch except compressed air piping), Brazed joint (2 inch and larger for piping other than compressed air and all sizes for compressed air piping), material to match tubing. Fittings shall conform to ANSI B16.18, or ANSI/ASME B16.22. Where required for connection to equipment, valves, and accessories, ANSI B16.24, class 150, cast bronze, brazed joint.

2-1.04. Material Classification CU-4. Not used.

2-1.05. Material Classification CU-5. Not used.

2-1.06. Material Classification CU-6. Not used.

2-1.07. Material Classification CU-7. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 15091

MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of manually operated or remote activated two position (open-close) ball valves as specified herein.

Miscellaneous ball valves shall be provided where AWWA type ball valves are not required.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.

1-2.02. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2-1. CONSTRUCTION. Ball valves shown on the drawing, but not specified herein, shall be selected to match piping material they are installed in.

2-1.01. Valves Type VB-1.

VB-1	Rating	500 psi [3.4 MPa] nonshock cold WOG
Instrument air, heating water, chilled water,	Code	MSS SP-110
	Type	In-line, two piece, end entry, full port

and condenser water systems with copper pipe, ball valves indicated on the plumbing drawings for water service in metallic piping systems. 2 inch and smaller	Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal End Connection Temp. Limitations Valve Operator Manufacturers	ASTM B584–C84400 bronze Reinforced Teflon Brass, or chrome plated brass Brass or bronze Reinforced Teflon Teflon or Viton Threaded End -20 to 400°F [-29 to 204°C] Lever Conbraco Industries "Apollo 77-100 Series"; Powell "Fig 4210T"

2-1.02. Valves Type VB-2.

VB-2 Ball valves indicated on the plumbing drawings for water service for metallic piping systems 2-1/2 inch and 3 inch	Rating Code Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal End Connection Temp. Limitations Valve Operator Manufacturers	500 psi [3.4 MPa] nonshock cold WOG MSS SP-110 In-line, three piece, end entry, full port ASTM B584-C84400 Bronze Reinforced Teflon Brass or chrome plated Brass or Bronze Reinforced Teflon Teflon or Viton Threaded End -20 to 400°F [-29 to 204°C] Lever Conbraco Industries "Apollo 82-100 Series"

2-1.03. Valves Type VB-3. Not used.

2-1.04. Valves Type VB-4.

VB-4 Digester gas	Rating Code	1000 psi [6.9 MPa] nonshock cold WOG MSS SP-110, NACE MR-01-75

service	Type	In-line, three piece, bolted body, regular port
2 inch and smaller	Body/Bonnet	ASTM A351-CF8M, stainless steel
	Trim	
Socket weld	Seat	Reinforced Teflon
	Ball	ASTM A276-316 stainless steel
	Stem	ASTM A276-316 stainless steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Socket weld
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 85-200 Series"; Neles-Jamesbury "Series 4000"

2-1.05. Valves Type VB-5.

VB-5	Rating	Class 150
	Code	
Compressed air, water service	Type	In-line, split-body, full port
	Body/Bonnet	ASTM A216-WCB, cast steel
	Trim	
2-1/2 inch	Seat	Reinforced Teflon
	Ball	ASTM A216-WCB, steel, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Stem Packing	Manufacturer’s standard
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 88A-200 Series"

2-1.06. Valves Type VB-6.

VB-6	Rating	Class 150
	Type	In-line, end entry, regular port
Compressed air, water service	Body/Bonnet	ASTM A216-WCB, cast steel
	Trim	

	Seat	Reinforced Teflon
3 inch and larger	Ball	ASTM A216-WCB, steel, chrome plated
	Stem	ASTM A108-CS
Flanged	Thrust Washer	Reinforced Teflon
	Body Seal	Reinforced Teflon
	Stem Seal	Manufacturer's standard
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 88A-100 Series", Neles-Jamesbury "5000 Series", Powell "Fig 4224T"

2-1.07. Valves Type VB-7. Not used.

VB-7	Rating	800 psi [5.5 MPa] nonshock cold WOG
Heating water, chilled water, and condenser water systems with steel pipe, compressed air service	Code	ASME B16.34
	Type	In-line, three piece, bolted body, full port
	Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A108-CS, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
2 inch and smaller	Stem Seal	Reinforced Teflon
	End Connection	Socket weld
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever or Electric
	Manufacturers	Contromatics "C-1122-BB-DL", Conbraco Industries "Apollo 83-200 Series", Neles-Jamesbury "4DX2200TT"
	Valve Operator Lever	Contromatics "C-1122-BB-DLConbraco Industries "Apollo 83R-200 Series", Neles-Jamesbury "4DX2200TT"
	Valve Operator Electric	Conbraco Industries "Apollo 83R-242"

2-1.08. Valves Type VB-8.

VB-8 Compressed air, water service 2-1/2 inch through 4 inch Butt weld	Rating Code Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal End Connection Temp. Limitations Valve Operator Manufacturers	800 psi [5.5 MPa] nonshock cold WOG ASME B16.34 In-line, three piece, bolted body, regular port ASTM A105, forged steel or ASTM A216-WCB, cast steel Reinforced Teflon Nickel or hard chrome plates carbon steel Nickel or hard chrome plated carbon steel Reinforced Teflon Reinforced Teflon Butt weld -20 to 400°F [-29 to 204°C] Lever Worcester Controls “4546TTBW4”

2-1.09. Valves Type VB-9. Not used.

2-1.10. Valves Type VB-10.

VB-10 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section 4 inch and smaller Socket	Rating Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal Body Seals End Connection	150 psig [1.0 MPa] nonshock cold WOG In-line, true union, full port (Schedule 80) PVC or CPVC to match piping system Teflon PVC or CPVC to match piping system PVC or CPVC to match piping system Teflon Viton O-ring Viton O-rings Socket

	Temp. Limitations	0 to 140°F [-18 to 60°C]
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co "True Union 2000 Standard Series 3600 Ball Valve"

2-1.11. Valves Type VB-11.

VB-11	Rating	150 psig [1.0 MPa] nonshock cold WOG
Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon
	Ball	PVC or CPVC to match piping system
4 inch and smaller	Stem	PVC or CPVC to match piping system
	Thrust Washer	Teflon
Flanged	Stem Seal	Viton O-ring
	Body Seals	Viton O-rings
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	0 to 140°F [-18 to 60°C]
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co. "True Union 2000 Standard Series 3600 Ball Valve"

2-1.12. Valves Type VB-12. Not used.

2-1.13. Valves Type VB-13. Not used.

2-1.14. Valves Type VB-14. Not used.

2-1.15. Valves Type VB-15. Not used.

2-1.16. Valves Type VB-16. Not used.

2-1.17. Valves Type VB-17.

VB-17 Water service 2 inch and smaller	Rating	2000 psi nonshock cold WOG
	Type	In-line, two piece, end entry, full port
	Body/Bonnet	ASTM B548-C84400, bronze
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A276-316, stainless Steel
	Stem	ASTM A276-316, stainless Steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F
	Valve Operator	Electric Actuator
	Manufacturers	Conbraco Industries “Apollo 77-Arx-35-00 Series”

2-1.18. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch [1.6 mm] of the specified or theoretical length.

2-1.19. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy.
Exterior Surfaces of all other valves	Universal primer.

2-2. VALVE ACTUATORS. Ball valve, except those which are equipped with power actuators or are designed for automatic operation, shall be provided with manual actuators. Unless otherwise specified or indicated on the drawings, each manual actuator shall be equipped with a lever operator. Ball valves with center lines more than 7'-6" [2.3m] above the floor shall be provided with chain levers.

Valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2-3. ACCESSORIES. If the drawings indicate the need for extension stems, stem guides; position indicator; floor boxes; valve boxes; or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

Section 15094

BACKFLOW PREVENTERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of backflow preventers and associated appurtenances, as indicated herein. Backflow preventers for fire protection service shall be as specified in the fire sprinklers systems section.

Piping, pipe supports, insulation, and accessories which are not an integral part of the backflow preventers or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to the following:

Name of manufacturer.
Type and model.
Construction materials and finishes.
Net weight.
Unit dimensions.
Performance curves indicating flow capacity versus pressure drop.

1-3.02. Operations and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Backflow preventers shall be designed to meet the requirements as indicated herein and in the Backflow Preventer Schedule on the Drawings.

2-2. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Design and Construction paragraph.

2-3. DESIGN AND CONSTRUCTION. Backflow prevention device type shall be as indicated herein.

2-3.01. Reduced Pressure Zone Backflow Preventers. Reduced pressure zone (RPZ) backflow preventers shall consist of isolation valves, two independent check valves, and differential relief valve. The assembly shall automatically reduce the pressure in the zone between the check valves. In the event that the reduced pressure is not maintained, the differential relief valve shall open, maintaining the proper zone differential. RPZ backflow preventers shall comply with AWWA C511 and ASSE Standard 1013 requirements and shall be suitable for horizontal installation. Backflow preventers shall comply with the requirements of ANSI/NSF 61, Annex G for low lead. Each RPZ backflow preventer shall be provided with a relief valve air-gap drain fitting.

RPZ backflow preventers in 2 inch [50 mm] and smaller sizes shall be provided with bronze bodies and with a threaded bronze bodied ball valve on each end of the device. Two inch [50 mm] and smaller RPZ backflow preventers shall be Febco “Model LF860”, Wilkins “Model 975XL2”, or Watts Regulator “Series LF919”.

RPZ backflow preventers in 2-1/2 inch [63 mm] and larger sizes shall be provided with 304 stainless steel or ductile iron bodies with epoxy-coated interior and exterior, and a flanged, resilient-seated gate valve on each end of the device. Flange diameter and drilling shall conform to ANSI/ASME B16.1, Class 125. 2-1/2 inch [63 mm] and larger RPZ backflow preventers shall be Wilkins “Model 375” or Watts Regulator Company “Series 957”.

2-3.02. Hose Connection Vacuum Breakers. Hose connection vacuum breakers shall be provided with 3/4 inch [19 mm] hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, manual drain feature, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be Febco “Series 731”, Watts Regulator Company “Series 8” or Wilkins “Model BFP 8”.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Valve Installation section.

END OF SECTION

Section 15099

PRESSURE REDUCING VALVES

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing of pressure reducing valves as specified herein.

Piping, pipe supports, insulation, and accessories which are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Valves specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.

Type and model.

Construction materials and finishes.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in

addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Pressure reducing valves shall be designed to meet the service requirements as indicated herein and in the Pressure Reducing Valves Schedule on the Drawings.

Each pressure reducing valve shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.

2-2. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Construction paragraph.

2-3. MATERIALS. Valve materials shall be as indicated below and in the Construction paragraph.

Shop Coatings

Epoxy Enamel, NSF certified (Liquid Service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus"; immersion service.
Epoxy Enamel (Gas and Air Service)	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".

2-4. CONSTRUCTION.

2-4.01. Water Service. Pressure reducing valves for water service shall be direct-acting or pilot-operated type as indicated in the Pressure Reducing Valve Schedule.

Direct-acting valves shall be globe type with threaded connections and union assembly. The valves shall be provided with bronze body and cover, stainless steel trim, reinforced neoprene diaphragm, Buna-N disc, and stainless steel strainer. Direct-acting pressure reducing valves shall be Cla-Val “Model 990”, Cash-Acme, or Watts.

When indicated in the schedules, pilot-operated valves shall be equipped with a low flow bypass. The low flow bypass shall consist of a direct-acting pressure reducing

valve in parallel with the pilot-operated valve. The valves and required piping assembly shall be factory assembled and shall be Cla-Val “Model 90-48”, Watts, or OCV.

2-4.02. Gas Service. Not Used.

2-4.03. Air Service. Pressure reducing valves for air service shall have a cast iron or steel body with stainless steel trim and a composition disc. Pressure reducing valves shall be furnished with integral or line mounted inlet filters/strainers and discharge pressure gauges. Valves shall be as manufactured by Fisher Controls; O. C. Keckley Co.; Leslie Controls, Inc.; Spirax Sarco, Inc; or equal.

2-5. SAFETY VALVES FOR AIR SERVICE. Not Used.
2-6. SHOP PAINTING. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop painted for corrosion protection in accordance with the following list. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Protective Coatings section.

Interior Surfaces	
Liquid Service	Epoxy (NSF certified).
Exterior Surfaces	Universal primer with epoxy finish coat.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

Section 15100

VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of the following types of valves as specified herein and as indicated in the valve schedules, except where specific requirements are stipulated in other sections.

Check Valves
Globe Valves
Miscellaneous Ball Valves
Pinch and Diaphragm Valves
Plug Valves
Hose Faucets, Hydrants, and Curb Stops
Basin valves
Butterfly valves
Air Release Valves
Air Release/Vacuum Valves
Surge Anticipating and Relief Valves

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications, covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2-1. CHECK VALVES (VC) CONSTRUCTION.

2-1.01 Valves VC-1.

VC-1 Air or vacuum service 1-1/2 inch or smaller pipe	Type Body Trim Poppet O-ring Spring End Connection Temp. Limitations Manufacturers	Poppet Stainless steel Stainless steel Viton (EPDM for aqua ammonia system air supply) Stainless steel Threaded -20 to 375°F Circle Seal “Series 200” or Swagelok “Series C”

2-1.02. Valves VC-2.

VC-2 Water, sludge, liquid service, or sump pump discharge Threaded ends 2 inch or smaller pipe	Rating Code Type Body/Bonnet Trim Seat Disc Hinge Pins End Connection Temp. Limitations Manufacturers	Class 125 AWWA C508 Horizontal swing, threaded bonnet ASTM B62 bronze Bronze, regrinding Bronze Manufacturer’s standard Threaded -20 to 212°F Stockham “B-321”, Walworth “Fig 3406”

2-1.03. Valves VC-3.

VC-3 Water,	Rating Code Type	Class 125 AWWA C508 Horizontal swing, threaded bonnet

sludge, or liquid service Socket ends 2 inch or smaller pipe	Body/Bonnet Trim Seat Disc Hinge Pins End Connection Temp. Limitations Manufacturers	ASTM B62 bronze Bronze, regrinding Bronze Manufacturer's standard Soldered -20°F to 212°F Nibco "S-413-B", Walworth "Fig 3046SJ"

2-1.04. Valves VC-4.

VC-4 Air or vacuum service 2 inch or larger pipe	Rating Type Body Trim Seat Disc Hinge Pins Springs Bushings End Connection Temp. Limitations Manufacturers	Class 125 Dual disc wafer Cast iron EPDM Aluminum Aluminum Stainless steel Manufacturer's standard Plain, installed between ASME B16.1, Class 125, flat faced flanges -20 to 300°F Cameron Valves "Short Form Style 5118 Check Valves", Hoffman "Air Check Valves", Lamson "Check Valves"

2-1.05. Valves VC-5. .

VC -5 Wastewater Pump Discharge Service Transfer Pump Station Pumps PCL-10, 20,30, 40, 50, and 60, Check Valves	Rating Code Type Body Trim Seat Ring Disc Hinge Pins Bearings Cover Gasket End Connection Temp. Limitations	Class 125 AWWA C508 Horizontal swing, "Shockless Swing-Check ASTM A126 Class B cast iron ASTM B763 Alloy 84400 bronze ASTM A126 Class B cast iron Stainless steel Bronze bushings Manufacturer's standard Flanged, ASME B16.1, Class 125, flat faced -20 to 212°F

	Valve Operator	External weighted lever, the action of which is cushioned by a hydraulic oil or pneumatic cylinder
	Manufacturers	GA Industries, APCO, Val-Matic, or Approved Equal.”

2-1.06. Valves VC-6.

VC-6 Water, sludge, or liquid service 2-1/2 inch and larger pipe	Rating	Class 125
	Code	AWWA C508
	Type	Horizontal swing, bolted bonnet
	Body/Bonnet	ASTM A126 Class B cast iron
	Trim	
	Seat Ring	Bronze
	Disc	Bronze
	Hinge Pins	Bronze or brass
	Bushings	Bronze
	Cover Gasket	Manufacturer’s standard
	End Connection	Flanged, ASME B16.1 Class 125, flat faced
	Temp. Limitations	-20 to 212°F
	Manufacturers	Milwaukee “F-2974”, Stockham “G-931”

2-1.07. Valves VC-7.

VC-7 Sump pump discharge service 3 inch and larger pipe	Rating	Class 125
	Code	AWWA C508
	Type	Horizontal swing, bolted bonnet
	Body/Bonnet	ASTM A126 Class B cast iron
	Trim	
	Seat Ring	ASTM B763 Alloy 84400 bronze
	Disc (3 inch)	ASTM B584 bronze
	(4 inch and larger)	ASTM A126 Class B cast iron
	Hinge Pins	Stainless steel
	Bearings	Bronze bushings
	Cover Gasket	Manufacturer’s standard
	End Connection	Flanged, ASME B16.1 Class 125, flat faced
	Temp. Limitations	-20 to 212°F
	Valve Operator	Weighted lever
	Manufacturers	Mueller “A2604-6-01”

2-1.08. Valves VC-8.

VC-8 Low pressure clear water service 3 through 12 inch pipe	Rating	Class 125
	Type	Dual disc wafer
	Body	ASTM A126, Class B, cast iron
	Trim	
	Seat Ring	Buna-N
	Disc	ASTM B148 Alloy 952, aluminum bronze
	Springs/Hinge Pins/Stops	Stainless steel
	Bearings	Teflon
	End Connection	Plain, installed between ASME B16.1, Class 125, flat faced flanges
	Temp. Limitations	-20 to 225°F intermittent, 0 to 180°F continuous
	Manufacturers	Marlin “Wafer Check 125HZNSF”, Stockham “WG-970”, “Duo-Chek II 12HMP”, Apco Valve and Primer “9000AR1F”

2-1.09. Valves VC-9.

VC-9 High pressure clear water service 3 through 12 inch pipe	Rating	Class 250
	Type	Dual disc wafer
	Body/Bonnet	ASTM A126, Class B, cast iron
	Trim	
	Seat	Buna-N
	Disc	ASTM B148 Alloy 952, aluminum bronze
	Springs/Hinge Pins/Stops	AISI Type 316 stainless steel
	Bearings	Teflon
	End Connection	Plain, installed between ASME B16.1, Class 250, raised faced flanges
	Temp. Limitations	-20 to 225°F intermittent, 0 to 180°F continuous
	Manufacturers	Marlin “Wafer Check 250HZNSR”, Stockham “WG-970”, “Duo-Chek II Figure 30HMF”, Apco Valve and Primer “9200AR1R”

2-1.10. Valves VC-10.

VC -10 Wastewater pump discharge service 6 inch and larger pipe	Rating Code Type Body Trim Seat Ring Disc Hinge Pins Bearings Cover Gasket End Connection Temp. Limitations Valve Operator Manufacturers	Class 125 AWWA C508 Horizontal swing, bolted bonnet ASTM A126 Class B cast iron ASTM B763 Alloy 84400 bronze ASTM A126 Class B cast iron Stainless steel Bronze bushings Manufacturer's standard Flanged, ASME B16.1, Class 125, flat faced -20 to 212°F External spring or weighted lever American Flow Control "52 SC", M&H "Style 259-02", Mueller "A2600-6-01 or 6-02"

2-1.11. Valves VC-11. Not used.

2-1.12. Valves VC-12. Not used.

2-1.13. Valves VC-13.

VC-13 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section Socket ends 4 inch and smaller PVC or CPVC pipe	Rating Type Body Trim Ball Seat Seals End Connection Temp. Limitations Manufacturers	150 psig nonshock Ball check, true union PVC or CPVC, material shall match pipe material PVC or CPVC, material shall match pipe material Viton or EPDM Viton or EPDM Socket 0 to 140°F Hayward Plastics Products "Ball Check Valve", Nibco "Chemtrol True Union Ball Check Valve", Spears Manufacturing Co. "True Union 2000 Industrial Series 4500 Ball Check Valves"

2-1.14. Valves VC-14.

VC-14 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories Section Flanged ends 4 inch and smaller PVC or CPVC pipe	Rating Type Body/Bonnet Trim Ball Seat Seals End Connection Temp. Limitations Manufacturers	150 psig nonshock Ball check, true union PVC or CPVC, material shall match pipe material PVC or CPVC, material shall match pipe material Viton or EPDM Viton or EPDM Flanged, ASME B16.5, Class 150, raised face 0 to 140°F Hayward Plastics Products “Ball Check Valve”, Nibco “Chemtrol True Union Ball Check Valve”, Spears Manufacturing Co. “True Union 2000 Industrial Series 4500 Ball Check Valves”

2-1.15. Valves VC-15.

VC-15 Chemical feed service 2 inch and smaller carbon steel pipe	Rating Type Body/Bonnet Trim Ball Seat Gasket Spring End Connection Temp. Limitations Manufacturers	Class 150 Spring loaded ball check with bolted removable cap Carbon steel Alloy steel A276 Stellite 6 316 Stainless Steel/Grafoil, Spiral Wound Stainless Steel Type 302 Socket welded 0 to 150°F Bonney Forge “HL51SW”

2-1.16. Valves VC-16. Not Used

2-1.17. Valves VC-17.

VC-17 Chemical piping vacuum relief service	Rating Type Body Trim Diaphragm End Connection	100 psig nonshock Diaphragm, two piece PVC or CPVC to match pipe Chemical resistant Threaded

PVC or CPVC pipe	Temp. Limitations Manufacturers	0 to 140°F Plast-O-Matic “Series CKM Check Valves” or “Series VB Vacuum Breakers”

2-1.18. Valves VC-18. Not used.

2-1.19. Valves VC-19.

VC-19 Chemical piping vacuum relief service Carpenter 20 pipe	Rating Type Body/Bonnet Trim Seat End Connection Temp. Limitations Manufacturers	3000 psig nonshock Vacuum breaker, Universal low pressure check valve Carpenter 20 Cb-3 Teflon Threaded 0 to 140°F Check-All Valves “UN-3-XXX-A-20-T” or equal

2-2. Globe Valves (VGL) Construction

2-2.01 Valves VGL-1.

VGL-1 Instrument air, clear water service 1/2 inch pipe and smaller	Rating Code Type Body/Bonnet Trim Seat Stem Bonnet Gasket Stem Packing End Connection Temp. Limitations Valve Operator Manufacturers	Class 200 MSS SP-80 In-line, union or threaded bonnet, rising stem, needle Bronze or brass Manufacturer’s standard Bronze Manufacturer’s standard Manufacturer’s standard Threaded 0 to 400°F Handwheel Milwaukee "600", Powell "Fig 180", Stockham "B-64".

2-2.02 Valves VGL-2.

VGL-2	Rating	Class 125

Globe valves indicated on plumbing drawings, clear water service 3/4 to 2 inch pipe Threaded	Code	MSS SP-80, Type 1
	Type	In-line, metal disc, threaded bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
	Seat	Integral to body
	Disc	Bronze
	Stem	Bronze
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
	End Connection	Threaded
	Temp. Limitations	0 to 350°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "502", Stockham "B-16", Nibco "T-211".

2-2.03 Valves VGL-3.

VGL-3 Clear water service 3/4 to 2 inch pipe Soldered	Rating	Class 125
	Code	MSS SP-80, Type 1
	Type	In-line, metal disc, threaded bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
	Seat	Integral to body
	Disc	Bronze
	Stem	Bronze
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
	End Connection	Soldered
	Temp. Limitations	0 to 250°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1502", Stockham "B-17".

2-2.04 Valves VGL-4.

VGL-4 Instrument air compressed air service 3/4 to 2 inch pipe	Rating	Class 150
	Code	MSS SP-80, Type 2
	Type	In-line, composition disc, union bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
	Seat	Integral to body
	Disc	Teflon

Threaded	Stem	Bronze
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
	End Connection	Threaded
	Temp. Limitations	0 to 350°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1590", Stockham "B-22T", Walworth "Fig 3095".

2-2.05 Valves VGL-5.

VGL-5	Rating	Class 150
	Code	
Instrument air, compressed air service	Type	In-line, composition disc, union bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
3/4 to 2 inch pipe	Seat	Integral to body
	Disc	Teflon
	Stem	ASTM B62, bronze
Soldered	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Teflon impregnated
	End Connection	Soldered
	Temp. Limitations	0 to 250°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1590".

2-2.06 Valves VGL-6.

VGL-6	Rating	Class 150
	Code	MSS SP-85, Type I
Globe valves indicated on plumbing drawings, instrument air, compressed air, clear water service	Type	In-line, bolted bonnet, OS&Y rising stem
	Body/Bonnet	ASTM A126 Class B, cast iron
	Trim	
	Seat Ring	ASTM B62, bronze
	Disc	ASTM B62, bronze
	Stem	Brass or silicone bronze
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
2-1/2 inch pipe and larger	End Connection	Flanged, ASME B16.1, Class 125, flat faced
	Temp. Limitations	0 to 250°F
	Valve Operator	Handwheel

	Manufacturers	Milwaukee "F2981", Powell "Fig 1253", Walworth "8096F".

2-2.07 Valves VGL-7.

VGL-7 Wastewater 2 inch pipe and smaller	Rating	Class 250
	Type	In-line, single seated, top guided, bolted bonnet
	Body/Bonnet	Cast iron
	Trim	
	Plug	316 stainless steel
	Seat Ring	316 stainless steel
	Stem	Manufacturer's standard
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
	End Connection	Threaded
	Temp. Limitations	0 to 250°F
	Valve Operator	Electric
	Manufacturers	Dezurik "Series 1400".

2-2.08 Valves VGL-8.

VGL-8 Wastewater 2-1/2 inch pipe and larger	Rating	Class 125
	Type	In-line, single seated, cage, bolted bonnet
	Body/Bonnet	Cast iron
	Trim	
	Plug	17-4 PH stainless steel
	Seat Ring	17-4 PH stainless steel
	Stem	Manufacturer's standard
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
	End Connection	Flanged, ASME B16.1, Class 125, flat faced
	Temp. Limitations	0 to 350°F
	Valve Operator	Electric
	Manufacturers	Dezurik "Series 9100".

2-2.09 Valves VGL-9.

VGL-9 Chemical feed service	Rating	Class 150
	Type	In-line, threaded bonnet, rising stem
	Body/Bonnet	PVC
	Trim	

4 inch pipe and smaller	Disc	Polypropylene
	Stem	PVC
	Stem Packing	EPDM or Viton
	End Connection	Socket welded (2 inch and smaller) Flanged, Class 150, (2-1/2 and larger)
	Temp. Limitations	0 to 140°F
	Valve Operator	Handwheel
	Manufacturers	Asahi “Model B”.

2-2.10 Valves VGL-10.

VGL-10 Chemical feed service 4 inch pipe and smaller	Rating	Class 150
	Type	In-line, threaded bonnet, rising stem
	Body/Bonnet	
	Trim	PVC
	Disc	Polypropolene
	Stem	Polypropolene
	Stem Packing	EPDM or Viton
	End Connection	Socket welded (2 inch and smaller) Flanged, Class 150, (2-1/2 and larger)
	Temp. Limitations	0 to 200°F
	Valve Operator	Handwheel
	Manufacturers	Asahi “Model B”.

2-2.11 Valves VGL-11.

VGL-11 Anhydrous ammonia service 4 inch pipe and smaller	Rating	Class 300
	Type	In-line, bolted bonnet, rising stem
	Body/Bonnet	Ductile iron
	Trim	
	Seat	Teflon
	Stem	Stainless steel
	End Connection	Flanged, Class 300 or threaded
	Temp. Limitations	0 to 250°F
	Valve Operator	Handwheel
	Manufacturers	Rego “TA5700 Series”.

2-2.12 Valves VGL-12.

VGL-12	Rating	Class 250

Heating water service 1 through 16 inch pipe	Type	Three-way, top guided skirt, mixing or diverting as required
	Body/Bonnet	Cast iron
	Trim	
	Plug	Linear, V-port, 316 stainless steel
	Seat Ring	316 stainless steel
	Stem	Manufacturer's standard
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
	End Connection	Flanged
	Temp. Limitations	0 to 250°F
	Valve Operator	Electric as specified in Valve and Gate Actuators section
	Manufacturers	Dezurik "Series 1601".

2-3. MISCELLANEOUS BALL VALVES (VB) CONSTRUCTION

2-3.01 Valves Type VB-1.

VB-1 Instrument air, heating water, chilled water, and condenser water systems with copper pipe, ball valves indicated on the plumbing drawings for water service in metallic piping systems. 2 inch and smaller	Rating	500 psi nonshock cold WOG
	Code	MSS SP-110
	Type	In-line, two piece, end entry, full port
	Body/Bonnet	ASTM B584–C84400 bronze
	Trim	
	Seat	Reinforced Teflon
	Ball	Brass, or chrome plated brass
	Stem	Brass or bronze
	Thrust Washer	Reinforced Teflon
	Stem Seal	Teflon or Viton
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 77-100 Series"; Powell "Fig 4210T"

2-3.02 Valves Type VB-2.

VB-2 Ball valves indicated on the plumbing drawings for water service for metallic piping systems 2-1/2 inch and 3 inch	Rating	500 psi nonshock cold WOG
	Code	MSS SP-110
	Type	In-line, three piece, end entry, full port
	Body/Bonnet	ASTM B584-C84400 Bronze
	Trim	
	Seat	Reinforced Teflon
	Ball	Brass or chrome plated
	Stem	Brass or Bronze
	Thrust Washer	Reinforced Teflon
	Stem Seal	Teflon or Viton
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 82-100 Series"

2-3.03 Valves Type VB-3.

VB-3 Process air service 2 inch and smaller	Rating	800 psi [6.5 MPa] nonshock cold WOG
	Code	MSS SP-110
	Type	In-line, two piece, end entry, regular port
	Body/Bonnet	ASTM A351-CF8M, stainless steel
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A276-316, stainless steel
	Stem	ASTM A276-316, stainless steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Teflon or Viton
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 76-100 Series"; Neles-Jamesbury "Series 4000"

2-3.04 Valves Type VB-4.

VB-4	Rating	1000 psi [6.9 MPa] nonshock cold WOG
Digester gas service	Code	MSS SP-110, NACE MR-01-75
	Type	In-line, three piece, bolted body, regular port
2 inch and smaller	Body/Bonnet	ASTM A351-CF8M, stainless steel
	Trim	
Socket weld	Seat	Reinforced Teflon
	Ball	ASTM A276-316 stainless steel
	Stem	ASTM A276-316 stainless steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Socket weld
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 85-200 Series"; Neles-Jamesbury "Series 4000"

2-3.05 Valves Type VB-5.

VB-5	Rating	Class 150
	Code	
Compressed air, water service	Type	In-line, split-body, full port
	Body/Bonnet	ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
2-1/2 inch	Ball	ASTM A216-WCB, steel, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Stem Packing	Manufacturer’s standard
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 88A-200 Series"

2-3.06 Valves Type VB-6.

VB-6	Rating	Class 150

Compressed air, water service 3 inch and larger Flanged	Type	In-line, end entry, regular port
	Body/Bonnet	ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A216-WCB, steel, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Body Seal	Reinforced Teflon
	Stem Seal	Manufacturer's standard
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 88A-100 Series", Neles-Jamesbury "5000 Series", Powell "Fig 4224T"

2-3.07 Valves Type VB-7.

VB-7 Heating water, chilled water, and condenser water systems with steel pipe, compressed air service 2 inch and smaller	Rating	800 psi [5.5 MPa] nonshock cold WOG
	Code	ASME B16.34
	Type	In-line, three piece, bolted body, full port
	Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A108-CS, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Socket weld
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever or Electric
	Manufacturers	Contromatics "C-1122-BB-DL", Conbraco Industries "Apollo 83-200 Series", Neles-Jamesbury "4DX2200TT"
	Valve Operator Lever	Contromatics "C-1122-BB-DLConbraco Industries "Apollo 83R-200 Series", Neles-

	Valve Operator Electric	Jamesbury “4DX2200TT” Conbraco Industries “Apollo 83R-242”

2-3.08 Valves Type VB-8.

VB-8 Compressed air, water service 2-1/2 inch through 4 inch Butt weld	Rating	800 psi [5.5 MPa] nonshock cold WOG
	Code	ASME B16.34
	Type	In-line, three piece, bolted body, regular port
	Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	Nickel or hard chrome plates carbon steel
	Stem	Nickel or hard chrome plated carbon steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Butt weld
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Worcester Controls “4546TTBW4”

2-3.09 Valves Type VB-9.

VB-9 Diesel fuel, gasoline, lubrication oil, methanol, aqua ammonia service 2 inch and smaller	Rating	Class 600
	Code	ASME B16.34
	Type	In-line, three piece, bolted body, firesafe, full port
	Body/Bonnet	ASTM A105, forged steel
	Trim	
	Seat	Reinforced Teflon primary, metal secondary
	Ball	Stainless steel
	Stem	Stainless steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Threaded End (socket weld end for aqua ammonia)
	Temp. Limitations	-20 to 400°F [-29 to 204°C]

	Valve Operator Manufacturers	Lever Neles-Jamesbury "4B2236XT-1"

2-3.10 Valves Type VB-10.

VB-10 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section 4 inch and smaller Socket	Rating	150 psig [1.0 MPa] nonshock cold WOG
	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon
	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system
	Thrust Washer	Teflon
	Stem Seal	Viton O-ring
	Body Seals	Viton O-rings
	End Connection	Socket
	Temp. Limitations	0 to 140°F [-18 to 60°C]
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co "True Union 2000 Standard Series 3600 Ball Valve"

2-3.11 Valves Type VB-11.

VB-11 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section 4 inch and smaller	Rating	150 psig [1.0 MPa] nonshock cold WOG
	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon
	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system

Flanged	Thrust Washer	Teflon
	Stem Seal	Viton O-ring
	Body Seals	Viton O-rings
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	0 to 140°F [-18 to 60°C]
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co. "True Union 2000 Standard Series 3600 Ball Valve"

2-3.12 Valves Type VB-12.

VB-12 Distilled water, deionized water service 1 inch and smaller	Rating	150 psig [1.0 MPa] at 73°F [23°C]
	Type	In-line, Tru-union, end entry, regular port
	Body/Bonnet	Virgin unpigmented Type 1 Homopolymer Polypropylene
	Trim	Virgin unpigmented Type 1 Homopolymer Polypropylene
	End Connection	Socket weld
	Valve Operator	Lever
	Manufacturers	Orion "Whiteline Riontite"

2-3.13 Valves Type VB-13.

VB -13 Ozone gas, oxygen, aqua ammonia service 2 inch and smaller Flanged	Rating Code Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal End Connection Temp. Limitations Valve Operator Manufacturers	Class 150 ANSI B16.34 In-line, two piece, end entry, full port ASTM A3512-CF8M stainless steel Reinforced Teflon ASTM A276-316 stainless steel ASTM A276-316 stainless steel Reinforced Teflon Teflon or Viton Flanged, ASME B16.5, Class 150, raised face -20 to 400°F [-29 to 204°C] Lever Worcester "8266-TT 150 V20"; Neles-Jamesbury "9150-0-31-3600TTT"

2-3.14 Valves Type VB-14.

VB-14 Three-way ball valves in anti-siphon loop service 2 inch and smaller	Rating Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal Body Seals End Connection Temp. Limitations	150 psig nonshock cold WOG True union, three-way valve (Schedule 80) PVC or CPVC to match piping system Teflon PVC or CPVC to match piping system PVC or CPVC to match piping system Teflon Viton O-ring Viton O-rings Socket Weld 0 to 140°F

	Valve Operator	Lever
	Manufacturers	Asahi-America “Type 23 Multiport,” Hayward “Three-Way Ball Valves,” Nibco “3-Way Ball Valve,”

2-3.15 Valves Type VB-15. Not used.

2-3.16 Valves Type VB-16. Not used.

2-3.17 Valves Type VB-17.

VB-17 Water service 2 inch and smaller	Rating	2000 psi nonshock cold WOG
	Type	In-line, two piece, end entry, full port
	Body/Bonnet	ASTM B548-C84400, bronze
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A276-316, stainless Steel
	Stem	ASTM A276-316, stainless Steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F
	Valve Operator	Electric Actuator
	Manufacturers	Conbraco Industries “Apollo 77-Arx-35-00 Series”

2-4. PINCH VALVE (VPN) CONSTRUCTION

2-4.01. Valves VPN-1. Pinch valves shall consist of the valve body, elastomer sleeve liner, pinch bars, pull bars, actuator shaft, actuator base plate or yoke, actuator and assembly hardware. The valves shall be opened and closed with two mechanical pinch bars that constrict the elastomer sleeve liner between the bars. The pinch bars shall be enclosed inside the valve body. The top pinch bar shall be raised and lowered by a center actuator shaft. The lower pinch bar shall be raised and lowered with two pull bars anchored to the actuator base plate or yoke.

Valves shall provide 100 percent of the port area of the joining pipe at the valve ends and, unless otherwise specified, through the entire length of the valve. Valves shall be capable of closing bubble tight against the maximum line pressure.

2-4.02 Valve Body. Pinch valves shall be enclosed, split body design. All valves shall have flanged ends compatible with connecting piping. Flange diameter and drilling shall conform to ANSI B16.1, Class 125. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter.

2-4.03. Elastomer Sleeve Liner. Pinch valves shall be equipped with a one piece, seamless flange-to-flange elastomer sleeve liner specifically designed for the specified service conditions. The elastomer sleeve shall be compression molded or hand wrapped and reinforced with polyester cord ply. Pull tabs attached to the cord ply and extending through the exterior elastomer coating shall be furnished for attachment to the pinch bars to ensure positive opening force under negative pipeline pressure.

VPN-1	Rating	Class 125
	Body	Cast iron, ASTM A48
	Trim	
	Elastomer Sleeve Liner	Buna-N with polyester reinforcing cord ply
	Pull and Pinch Bars	Ductile iron or carbon steel when enclosed. Stainless steel, AISI Type 316 when exposed.
	Stem and Guide Rods	Stainless steel, AISI Type 316
	Assembly Hardware	Stainless steel, AISI Type 316
	End Connection	Flanged, ASME B16.1, Class 125, flat faced
	Valve Operator	Manual with handwheel
	Temp. Limitations	40 to 225°F
	Pressure Limitations	
	6 inch and smaller	150 psig
	8 and 12 inch	100 psig
	14 inch and larger	50 psig
	Manufacturers	Onyx Valve Co. “Model DHC”, RF Technologies, Inc. “RF Valve”, or Red Valve, “Series 75”, RKL Moyno Inc., or Flexible Valve Co.

2-5. DIAPHRAGM VALVE (VD) CONSTRUCTION. Not used.

2-6. PLUG VALVES (VP) CONSTRUCTION

2-6.01 Valves VP-1.

VP-1 Natural gas, propane service 2-1/2 inch and smaller pipe	Rating	175 WOG
	Code	AGA Approved
	Body	Cast iron
	Trim	
	Plug Seal	Hycar
	Plug	Bronze or nickel plated cast iron
	Stem Seal	Buna
	End Connection	Threaded
	Temp. Limitations	-20 to 180°F [-29 to 82°C]
	Valve Operator	Lever
	Manufacturers	Key Port "Fig 425-RS51"

2-6.02 Valves VP-2.

VP-2 Natural gas, propane service 3 and 4 inch pipe	Rating	175 WOG
	Code	AGA Approved
	Body	Cast iron
	Trim	
	Plug Seal	Hycar
	Plug	Bronze or nickel plated cast iron
	Stem Seal	Buna
	End Connection	Flanged, ASME B16.1, Class 125
	Temp. Limitations	-20 to 180°F [-29 to 82°C]
	Valve Operator	Lever
	Manufacturers	Key Port "Fig 425-RS51"

2-6.03 Valves VP-2. Not Used.

2-7. SURGE ANTICIPATING AND RELIEF VALVES (VSG)

2-7.01. The Combination Surge Anticipator and Pressure Relief Control Valve shall be a pilot operated valve, designed to minimize the effects of water hammer and pressure surges. The valve shall sense hydraulic pressure changes above and below the adjustable setpoints of the pilot control system directly from the pump station discharge header. The valve shall be a hydraulically operated, piston and angle pattern type. The valve shall contain a single full-ported seat, with seat bore equal to size of valve. The piston shall be guided above the seat a distance equal to no less than 75% of the diameter of the seat. The piston shall be cushioned and so designed as to insure positive closure. The main valve shall be packed with a resilient seat packing and Buna o-ring seals to insure tight closure and prevent metal to metal friction and seating. The design shall be such that repairs and dismantling internally of main valve may be made without its removal from the line. A mechanical scraper ring shall be utilized to protect the internal seals. The valve shall be furnished with an inlet side gauge cock for

receiving gauges and testing purposes. The external controls and all associated rigid pilot piping and fittings necessary for proper operation (except the oil for the hydraulic chamber) shall be factory assembled and furnished with the valve

2-7.01.1. The springs shall be enclosed in a protective chamber and shall be concentric to the valve piston to insure proper alignment.

2-7.01.2. The pilot control system shall contain an external Y-Strainer, Adjustable Opening and Closing Speed, Low Pressure Opening Pilot with Test Valves and Pressure Gauge, High Pressure Relief Pilot, Hydraulic Accumulator with Drain Pilot, Valve Position Indicator and Isolation Ball Valves on all body connections. The pilot control system shall utilize stainless steel tube and fittings. The adjustment range of the high pressure relief pilot shall be 20-200 psi and the low pressure opening pilot shall be 10-175 psi.

2-7.02. The valve interior must be coated with an epoxy coating in accordance with Section 09940- Protective Coatings

VSG-1 Wastewater Service	Rating	Class 250
	Body	Cast Iron ASTM A-126
	Piston	
	Internal Components	Stainless Steel ASTM-A73 Grade CF-8 or CF-8M
	Seat ring and Seat supports	304 Stainless Steel
	End Connection	Flanged, ASME B16.1, Class 250,
	Operator	Handwheel override with travel-stop & position indicator
	Manufacturers	Ross Model 70SWR-E or Approved Equal”

2-8. AIR RELEASE VALVES (VA)

2-8.01. Air release valves for sewage and process wastewater shall permit unrestricted escape of air while pipelines are being filled. When a pipeline is full of liquid, the air valve shall close watertight when liquid enters the valve. The valve shall

allow small pockets of air, which accumulate when the pipeline is operating under pressure, to escape through a small orifice appropriately sized for a working pressure of 250 psi.

2-8.01.1. Valves shall not exhibit leaks or weeping of liquid past the large orifice seal over the range of operating pressures from 7.3 psi to twice rated working pressure.

2-8.01.2. Valves shall respond to the presence of air/gas by discharging it through the small orifice at any pressure within the specified range of operating pressures, i.e. 7.3 psi to 250 psi, and shall remain leak tight in the absence of air.

2-8.01.3. Valves shall react immediately to pipeline drainage or liquid column separation by the full opening of the large orifice so as to allow unobstructed air intake at the lowest possible negative internal pipeline pressure.

2-8.01.4. The valves shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection. The body shall have 2" NPT cleanout and 1" NPT drain connections on the sides of the casting. The cover shall be bolted to the valve body and sealed with a flat gasket. A threaded adjustable orifice button shall provide drop tight shut off to the full valve pressure rating.

2-8.01.4.1. Floats shall be unconditionally guaranteed against failure including pressure surges. Extended mechanical linkage shall provide suitable mechanical advantage so that the valve will open under full operating pressure

2-8.01.4.2. The valve interior must be coated with an epoxy coating in accordance with Section 09940- Protective Coatings.

VA-1 Wastewater Service	Rating	Class 250
	Body	Cast Iron ASTM A-126
	Cover	Cast Iron ASTM A-126
	Leverage Frame	Stainless Steel T316
	Seat	Stainless Steel T316
	Float	Stainless Steel T316
	Internal Components	Stainless Steel T316
	End Connection	Flanged, ASME B16.1, Class 250,
	Size	2"

	Manufacturers	Valvematic 48A, APCO Valves or Approved Equal”

2-9. AIR RELEASE/VACCUM VALVES (VAC)

2-9.01. Combination air and vacuum valves for sewage and process wastewater shall permit unrestricted escape of air while pipelines are being filled. When a pipeline is full of liquid, the air and vacuum valve shall close watertight when liquid enters the valve. The valve shall allow small pockets of air, which accumulate when the pipeline is operating under pressure, to escape through a small orifice appropriately sized for a working pressure of 250 psi. The air/vacuum valve shall also permit large quantities of air to enter through the orifice when the pipeline is being drained to break the vacuum.

2-9.01.1. The valve shall be dual type.

2-9.01.2. The valve shall have an integral anti-surge orifice mechanism, which shall operate automatically to limit surge pressures rise or shock induced by closure to less than two times the valve rated working pressure.

2-9.01.3. The intake orifice diameter shall be equal to the nominal size of the valve, e.g., a six-inch valve shall have a six-inch diameter intake orifice.

2-9.01.4. Large orifice sealing shall be effected by the flat face of the control float seating against a nitrile rubber 'O' ring housed in a dovetail groove circumferentially surrounding the orifice.

2-9.01.5. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal affixed into the control float. The nozzle shall have a flat seating land surrounding the orifice so that damage to the rubber seal is prevented.

2-9.01.6. The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur when the valve is subjected to a pressure two times greater than the valve rated working pressure.

VAC-1 Wastewater Service	Rating	Class 250
	Body	Cast Iron ASTM A-126
	Cover	Cast Iron ASTM A-126
	Leverage Frame	Stainless Steel T316
	Seat	Stainless Steel T316
	Float	Stainless Steel T316
	Internal	Stainless Steel T316

	Components	
	End Connection	Flanged, ASME B16.1, Class 250,
	Air vacuum valve inlet size	3”
	Air release orifice size	Minimum of ¼”
	Manufacturers	Valvematic 48A/302A, APCO Valves or Approved Equal”

2-10. HOSE FAUCETS, HYDRANTS, AND CURB STOPS.

2-10.01. Hose Faucets, VHF-1.

VHF-1 Hose faucet	Type	Faucet, threaded bonnet.
	Body/Bonnet	Brass.
	Trim	
	Seat	Manufacturer’s standard.
	Disc	Manufacturer’s standard.
	Stem	Manufacturer’s standard.
	Stem Seal	Manufacturer’s standard.
	End Connection	Threaded, male NPT x male HPT.
	Temp. Limitations	32°F to 212°F [0°C to 100°C].
	Valve Operator	T-handle.
	Manufacturers	Prier Brass "C - 138NP.75" or Dearborn Brass.

2-10.02. Wall Hydrants, VHF-2.

VHF-2 Wall hydrant	Type	Freezeproof.
	Body/Bonnet	Brass or bronze.
	Trim	
	Seat	Manufacturer's standard.
	Disc	Manufacturer's standard.
	Stem	Manufacturer's standard.
	Stem Seal	Manufacturer's standard.
	End Connection	Threaded, NPT x male HPT.
	Temp. Limitations	32°F to 212°F [0°C to 100°C].
	Valve Operator	Removable key.
	Manufacturers	Smith "5609", Wade " 8600", Woodford "60", or Zurn "Z-1315".

2-10.03. Wall Hydrants with Vacuum Breaker, VHF-3.

VHF-3 Wall hydrants with vacuum breaker	Type	Freezeproof, with vacuum breaker.
	Body	Brass or bronze.
	Trim	
	Seat	Manufacturer's standard.
	Disc	Manufacturer's standard.
	Stem	Manufacturer's standard.
	Stem Seal	Manufacturer's standard.
	End Connection	Threaded, NPT x male HPT.
	Temp. Limitations	32°F to 212°F [0°C to 100°C].
	Valve Operator	Removable key.
	Manufacturers	Smith "5609", or Wade " 8600".

2-10.04. Box Type Yard Hydrants, VHF-4.

VHF-4 Yard hydrant	Type	Nonfreeze, box type.
	Body	Brass or bronze.
	Trim	
	Seat	Manufacturer's standard.
	Disc	Manufacturer's standard.
	Stem	Manufacturer's standard.
	Stem Seal	Manufacturer's standard.
	Box, Cover, Casing	Bronze.
	End Connection	Threaded, NPT x HPT.
	Temp. Limitations	32°F to 212°F [0°C to 100°C].
	Valve Operator	Removable key.
	Manufacturers	Josam "Series 71600", Smith "5810", or Zurn "Z-1360/1365".

2-10.05. Post Type Yard Hydrants, VHF-5.

VHF-5 Post type yard hydrant	Type	Nonfreeze, post type.
	Body	Brass or bronze.
	Trim	
	Seat	Manufacturer's standard.
	Disc	Manufacturer's standard.
	Stem	Manufacturer's standard.
	Stem Seal	Manufacturer's standard.
	End Connection	Threaded, NPT x HPT.
	Temp. Limitations	32°F to 212°F [0°C to 100°C].
	Valve Operator	Removable key.
	Manufacturers	Smith "5910/5914", Wade "8610", or Zurn "Z-1385/1390".

2-10.06. Curb Stops, VCS-1.

VCS-1 Curb stop	Code	ANSI/AWWA C800.
	Type	Straight-through.
	Body	Brass or bronze.
	Trim	
	Seat	Manufacturer's standard.
	Plug/Ball	Manufacturer's standard.
	Stem	Manufacturer's standard.
	Stem Seal	Manufacturer's standard.
	End Connection	Threaded.
	Temp. Limitations	32°F to 212°F [0°C to 100°C].
	Valve Operator	T-handle.
	Manufacturers	Ford Meter Box "Ford Ball Valve", Hays "Nuseal Curb Stop", or Mueller "Mark II Oriseal".

2-10.07. Fire Hydrants. Fire hydrants will be furnished by the Owner and shall be installed by the Contractor.

Fire hydrants shall conform to ANSI/AWWA C502. The information required by Paragraph III. A. of the ANSI/AWWA C502 foreword shall be as indicated below.

Affidavit of compliance	Not required.
Catalog and maintenance data	Required.
Type of shutoff	Compression or gate.

Size of hydrant (valve opening)	as indicated in the Fire Hydrant Schedule.
Inlet connection	6 inch [150 mm], locked push-on.
Harnessing lugs	Not required.
Depth of bury	As indicated on the Drawings ft.
Outlet nozzles	Two 2-1/2 inch [63 mm] hose nozzles and one 4 inch [100 mm] pumper nozzle.
Outlet nozzle threads	See Note 1.
Direction to open	Counterclockwise.
Stem seals	O-ring.
Outlet nozzle cap chains	Required.
Drain outlet	Required.
Operating nut	See Note 2.
Outlet nozzle cap nut	See Note 2.

Notes

1. Outlet nozzle threads shall be the Owner's standard thread.
2. The operating nut and outlet nozzle cap nut shall be of the Owner's standard shape and size.

2-11. BASIN VALVES.

2-11.01. Basin Floor Pressure Relief Valves. Pressure relief valves shall be provided in basin bottom concrete slabs at the locations indicated on the Drawings. The valves shall be the size indicated on the Drawings, with cast iron body, nonseparating cast iron or bronze cover, neoprene or Buna-N seat, and bottom strainers, and shall be of a length suitable for the depth of concrete in which they are installed. Pressure relief valves shall be Trumbull Industries, Inc. "Tank Pressure Relief Valve - Floor Type" or Neenah "R-5000, Type C".

Crushed rock or gravel shall be installed below the slab as indicated on the Drawings. The crushed rock or gravel fill shall be covered with polyethylene film before the

concrete slab is placed. After the slabs are completed, holes shall be punched in the film beneath each valve.

2-11.02. Basin Wall Pressure Relief Valves. Pressure relief valves shall be provided in concrete basin sidewalls at the locations indicated on the Drawings. The valves shall be the size indicated on the Drawings, cast iron, bronze-mounted, with neoprene or Buna-N seat, and shall be Trumbull Industries, Inc. "Tank Pressure Relief Valve - Wall Type" or Neenah "R-5002, Type B". Each valve shall be provided with a strainer plug and a flange by the bell wall pipe. The flanged end of the wall pipes shall be set flush with the wall and shall be tapped for studs. Each wall pipe and pressure relief valve shall be installed so that flange bolt holes straddle the top center line. The strainer plug of each valve shall be caulked into the bell of the wall pipe with lead wool. Crushed rock or gravel shall be installed at the exterior of the basin wall as indicated on the Drawings.

2-11.03. Mud Valves. Mud valves shall be flanged or spigot end, nonrising or rising stem type as indicated on the Drawings, with threaded stem, seat ring, and gate ring of bronze. Each valve shall be provided with coupling nut, extension stem, stem guides, and operating stand, wheel, or wrench nut, as indicated on the Drawings. Mud valves shall be installed with the valve seat level.

2-11.04. Shear Gates. Shear gates shall be of cast iron, flanged end, with bronze seat rings, and shall be by Clow. Each gate shall be equipped with a lift handle of proper length for easy operation and shall be provided with a hook support to hold the gate in the fully open position and to support the lever when the gate is in the closed position.

2-12. BUTTERFLY VALVES. Unless otherwise specified, industrial butterfly valves shall be the rubber-seat, tight-closing type. Valves specified with an electric, air, or hydraulic actuators shall be the lugged wafer style. Valve discs shall seat at 90 degrees with the pipe axis.

Industrial butterfly valves with center lines more than 7’-6” [2.3m] above the floor shall be provided with chain-wheels and operating chains as specified herein.

Flanged end valves shall be of the short-body type. Where mechanical joint ends are specified, in the valve schedule, either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11 will be acceptable. For buried or submerged service, shaft seals shall be O-ring type.

2-12.01. Valves VBF-4.

VBF-4	Rating	Class 150
	Body	PVC, molded
Polymer and polymer solution	Shaft	AISI Type 316 stainless steel
	Trim	
	Seat	FPM (Viton)
	Disc	PVC or polypropylene
Water	Stem	316 stainless steel
	Stem Seal	Synthetic O-rings
	Shaft Bearings	Upper and lower bearings, reinforced Teflon
	End Connection	Flanged, ASME B16.5, Class 150 diameter and drilling
	Temperature Limitations	0 to 120 F
	Manual Valve Operator	Lever
	Manufacturer	Asahi American “Type 56”, Chemtrol “Model B”

2-12.02. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch [1.6 mm] of the specified or theoretical length.

2-12.03. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	Specification Compliance
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Rust-Preventive Compound	As recommended by the manufacturer.
Universal Primer	As recommended by the manufacturer.

Surfaces To Be Coated	Material
Unfinished Surfaces	
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2-13 ECCENTRIC PLUG VALVES

2-13.1. ACCEPTABLE MANUFACTURES. For double disc gate valves acceptable manufactures are American R/D, Ludlow-Rensselaer, and Mueller.

2-13.2. MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of double disc gate valves shall conform to the requirements of the governing standard.

2-13.3. VALVE CONSTRUCTION.

2-13.3.01. Ends. Valve ends shall be compatible with connecting piping and as indicated in the Double Disc Gate Valve Schedule. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of the governing standard.

Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch [125 µm]. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot [165 µm/m] of flange diameter.

2-13.3.02. Stem Seals. The stem shall be the non-rising type.The type of stem shall be as indicated in the Double Disc Gate Valve Schedule. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems.

2-13.3.03. Rotation. The direction of rotation of the handwheel or wrench nut to open the valve shall be to the left (counterclockwise).

2-13.3.04. Bypasses. All 16 inch [400 mm] and larger gate valves shall be provided with a bypass and a bypass valve. Bypasses and bypass valves shall comply with Section 4.4.17 and Table 8 of the governing standard.

2-13.3.05. Gearing. All 16 inch [400 mm] and larger gate valves shall be provided with gears and gear cases as indicated in the Double Disc Gate Valve Schedule. Gears and gear cases shall comply with Sections 4.4.14 and 4.4.15 and Table 7 of the governing standard.

2-13.3.06. Internal Rollers and Tracks. All 16 inch [400 mm] and larger valves installed in horizontal piping with the stem oriented horizontally shall be equipped with internal rollers and tracks as indicated in the Double Disc Gate Valve Schedule.

2-13.3.07. Shop Coatings. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried.	Coal tar epoxy.
Exterior Surfaces of Valves to be Submerged, or Installed in Manholes or Valve Vaults.	Epoxy enamel.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound
Actuators and Accessories	Universal primer.

Interior coatings shall comply with ANSI/AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Coal Tar Epoxy	15 mils [380 µm]
Epoxy Enamel	10 mils [250 µm]
Universal Primer	3 mils [75 µm]

2-14. LENGTH TOLERANCE. Unless otherwise specified, the actual length of valves shall be within ±1/16 inch of the specified or theoretical length.

2-15. SHOP COATINGS. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy (for liquid service)	PPG Amercoat "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Sherwin-Williams "Macropoxy 646NSF"or Tnemec "Series N140 Pota-Pox Plus".
Epoxy Enamel (plug valves)	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Epoxy or Epoxy enamel.
Exterior Surfaces of Valves to be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy or epoxy.
Exterior Surfaces of all Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2-16. VALVE ACTUATORS. Requirements for valve actuators shall be as specified in the Valve and Gate Actuator section.

2-17. ACCESSORIES. When the Drawings indicate the need for extension stems; position indicator; floor boxes; or operating stands, refer to the Valve and Gate Actuator section.

2-17.01. Valve Boxes. Each valve buried to a depth of 4 feet [1.2 m] or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches [125 mm] in inside diameter, shall be at least 3/16 inch [4.7 mm] thick, and shall be provided with suitable cast iron bases and covers.

Each valve buried deeper than 4 feet [1.2 m] shall be provided with a valve box consisting of a cast iron cover and base, and a 6 inch [150 mm] cast iron pipe section. The cover and base shall be Clay & Bailey "No. 2193NS". The pipe shaft shall extend from the valve to 5 inches [125 mm] inside the valve box base.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

3-1.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

End of Section

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type
1"	OC	FECL	VTW	16	IC009	3 Way Valve
1"	OC	FECL	VTW	17	IC009	3 Way Valve

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings.
2) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.
3) Valve Ends shall be as follows
   Flanged - in plant or vaulted
   Mechanical Joint - buried
4) Actuator types shall be as indicated on P&IDs drawings
5) If any conflicts are found between this valve schedule and the PID drawings, the information on the PID drawings prevail
6) FECL - VTW - 10 through 15 are part of the Duplex strainer assembly

Ball Valve Schedule

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type
1"	OC	NPW	VBM	1	IC009	Ball Valve
1"	OC	NPW	VBM	2	IC009	Ball Valve
1"	OC	NPW	VBM	3	IC009	Ball Valve
1"	OC	NPW	VBM	4	IC009	Ball Valve
1"	OC	NPW	VBM	5	IC009	Ball Valve
1"	OC	NPW	VBM	6	IC009	Ball Valve
1"	OC	FECL	VBM	7	IC009	Ball Valve
1"	OC	FECL	VBM	8	IC009	Ball Valve
1"	OC	FECL	VBM	9	IC009	Ball Valve
1"	OC	FECL	VBM	10	IC009	Ball Valve
1"	OC	FECL	VBM	11	IC009	Ball Valve
1"	OC	FECL	VBM	12	IC009	Ball Valve
1"	OC	FECL	VBM	13	IC009	Ball Valve
1"	OC	FECL	VBM	14	IC009	Ball Valve
1"	OC	FECL	VBM	15	IC009	Ball Valve
1"	OC	FECL	VBM	16	IC009	Ball Valve
1"	OC	FECL	VBM	17	IC009	Ball Valve
1"	OC	FECL	VBM	18	IC009	Ball Valve
1"	OC	FECL	VBM	19	IC009	Ball Valve
1"	OC	FECL	VBM	20	IC009	Ball Valve
1"	OC	FECL	VBM	21	IC009	Ball Valve
1"	OC	FECL	VBM	22	IC009	Ball Valve
1"	OC	FECL	VBM	23	IC009	Ball Valve
1"	OC	FECL	VBM	24	IC009	Ball Valve
1"	OC	FECL	VBM	25	IC009	Ball Valve
1"	OC	FECL	VBM	26	IC009	Ball Valve
1"	OC	FECL	VBM	27	IC009	Ball Valve
1"	OC	FECL	VBM	28	IC009	Ball Valve
1"	OC	FECL	VBM	29	IC009	Ball Valve
1"	OC	FECL	VBM	30	IC009	Ball Valve
1"	OC	FECL	VBM	31	IC009	Ball Valve
1"	OC	FECL	VBM	32	IC009	Ball Valve
1"	OC	FECL	VBM	33	IC009	Ball Valve

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type
1"	OC	FECL	VBM	34	IC009	Ball Valve
1"	OC	FECL	VBM	35	IC009	Ball Valve
1"	OC	FECL	VBM	36	IC009	Ball Valve
1"	OC	FECL	VBM	37	IC009	Ball Valve
1"	OC	FECL	VBM	38	IC009	Ball Valve
1"	OC	FECL	VBM	39	IC009	Ball Valve
1"	OC	FECL	VBM	40	IC009	Ball Valve
.5"	OC	RPS	VBM	10	IP001	Ball Valve
.5"	OC	RPS	VBM	11	IP001	Ball Valve
.5"	OC	RPS	VBM	12	IP001	Ball Valve
.5"	OC	RPS	VBM	13	IP001	Ball Valve
.5"	OC	RPS	VBM	14	IP001	Ball Valve
.5"	OC	RPS	VBM	15	IP001	Ball Valve
.5"	OC	RPS	VBM	16	IP001	Ball Valve
.5"	OC	RPS	VBM	17	IP001	Ball Valve
.5"	OC	RPS	VBM	10	IP002	Ball Valve
.5"	OC	RPS	VBM	11	IP002	Ball Valve
.5"	OC	RPS	VBM	12	IP002	Ball Valve
.5"	OC	RPS	VBM	13	IP002	Ball Valve
.5"	OC	PRS	VBM	19	IR002	Ball Valve
.5"	OC	PRS	VBM	20	IR002	Ball Valve
.5"	OC	PRS	VBM	21	IR002	Ball Valve
.5"	OC	PRS	VBM	22	IR002	Ball Valve
.5"	OC	PRS	VBM	23	IR002	Ball Valve
.5"	OC	PRS	VBM	24	IR002	Ball Valve
.5"	OC	PRS	VBM	25	IR002	Ball Valve
.5"	OC	PRS	VBM	26	IR002	Ball Valve
.5"	OC	PRS	VBM	27	IR002	Ball Valve
.5"	OC	PRS	VBM	28	IR003	Ball Valve
.5"	OC	PRS	VBM	29	IR003	Ball Valve
.5"	OC	PRS	VBM	30	IR003	Ball Valve
.5"	OC	PRS	VBM	31	IR003	Ball Valve
.5"	OC	PRS	VBM	32	IR003	Ball Valve

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type
.5"	OC	PRS	VBM	33	IR003	Ball Valve
.5"	OC	PRS	VBM	34	IR003	Ball Valve
.5"	OC	PRS	VBM	35	IR003	Ball Valve
.5"	OC	PRS	VBM	36	IR003	Ball Valve
.5"	OC	PRS	VBM	37	IR003	Ball Valve
.5"	OC	PRS	VBM	38	IR003	Ball Valve
.5"	OC	PRS	VBM	39	IR003	Ball Valve

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings
2) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.
3) Valve Ends shall be as follows
   Flanged - in plant or vaulted
   Mechanical Joint - buried
4) Actuator types shall be as indicated on P&IDs drawings
5) If any conflicts are found between this valve schedule and the PID drawings, the information on the PID drawings prevail

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings
2) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.
3) Valve Ends shall be as follows
   Flanged - in plant or vaulted
   Mechanical Joint - buried
4) Actuator types shall be as indicated on P&IDs drawings
5) If any conflicts are found between this valve schedule and the PID drawings, the information on the PID drawings prevail

Check Valve Schedule

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type
1"	CK	NPW	VCK	38	IC009	Check Valve
1"	CK	NPW	VCK	39	IC009	Check Valve
1"	CK	NPW	VCK	40	IC009	Check Valve
1"	CK	NPW	VCK	41	IC009	Check Valve
1"	CK	NPW	VCK	42	IC009	Check Valve
1"	CK	NPW	VCK	43	IC009	Check Valve
1"	CK	FECL	VCK	44	IC009	Check Valve
1"	CK	FECL	VCK	45	IC009	Check Valve
1"	CK	FECL	VCK	46	IC009	Check Valve
1"	CK	FECL	VCK	47	IC009	Check Valve
24"	CK	SCR	VCK	10	IP001	Check Valve
24"	CK	SCR	VCK	20	IP001	Check Valve
24"	CK	SCR	VCK	30	IP001	Check Valve
24"	CK	SCR	VCK	40	IP001	Check Valve
24"	CK	SCR	VCK	50	IP002	Check Valve
24"	CK	SCR	VCK	60	IP002	Check Valve
4"	CK	PSC	VCK	10	IB004	Check Valve
4"	CK	PSC	VCK	20	IB004	Check Valve
4"	CK	PSC	VCK	30	IB004	Check Valve
4"	CK	PSC	VCK	40	IB004	Check Valve

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings
2) Valve Ends shall be as follows
    Flanged - in plant or vaulted
    Mechanical Joint - buried
3) If any conflicts are found between this valve schedule and the PID drawings, the information on the PID drawings prevail

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type	
4"	OC	PSC	VPL	10	IB004	Eccentric Plug Valve	
4"	OC	PSC	VPL	20	IB004	Eccentric Plug Valve	
4"	OC	PSC	VPL	30	IB004	Eccentric Plug Valve	
4"	OC	PSC	VPL	40	IB004	Eccentric Plug Valve	
24"	OC	RPS	VPL	10	IP001	Eccentric Plug Valve	
24"	OC	RPS	VPL	20	IP001	Eccentric Plug Valve	
24"	OC	RPS	VPL	30	IP001	Eccentric Plug Valve	
24"	OC	RPS	VPL	40	IP001	Eccentric Plug Valve	
24"	OC	RPS	VPL	50	IP002	Eccentric Plug Valve	
24"	OC	RPS	VPL	60	IP002	Eccentric Plug Valve	
24"	OC	RPS	VPL	150	IP002	Eccentric Plug Valve	
6"	OC	RPS	VPL	R34	IR001	Eccentric Plug Valve	
6"	OC	RPS	VPL	R35	IR001	Eccentric Plug Valve	
6"	OC	RPS	VPL	R36	IR001	Eccentric Plug Valve	
6"	OC	RPS	VPL	R37	IR001	Eccentric Plug Valve	
6"	OC	RPS	VPL	R38	IR001	Eccentric Plug Valve	
6"	OC	RPS	VPL	R39	IR001	Eccentric Plug Valve	
6"	OC	RPS	VPL	R40	IR001	Eccentric Plug Valve	
6"	OC	RPS	VPL	R41	IR001	Eccentric Plug Valve	
6"	**OC**	**RPS**	**VPL**	**R42**	**IR001**	**Eccentric Plug Valve**	***Additive Alternative***
6"	**OC**	**RPS**	**VPL**	**R43**	**IR001**	**Eccentric Plug Valve**	***Additive Alternative***
6"	**OC**	**RPS**	**VPL**	**R44**	**IR001**	**Eccentric Plug Valve**	***Additive Alternative***
6"	**OC**	**RPS**	**VPL**	**R45**	**IR001**	**Eccentric Plug Valve**	***Additive Alternative***
4"	OC	PRS	VPL	3	IR002	Eccentric Plug Valve	
4"	OC	PRS	VPL	4	IR002	Eccentric Plug Valve	
4"	OC	PRS	VPL	5	IR002	Eccentric Plug Valve	
4"	OC	PRS	VPL	6	IR002	Eccentric Plug Valve	
4"	OC	PRS	VPL	11	IR002	Eccentric Plug Valve	
4"	OC	PRS	VPL	12	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	21	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	21A	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	21B	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	21C	IR002	Eccentric Plug Valve	

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type	
6"	OC	PRS	VPL	22	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	22A	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	22B	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	22C	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	23	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	23A	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	23B	IR002	Eccentric Plug Valve	
6"	OC	PRS	VPL	23C	IR002	Eccentric Plug Valve	
4"	OC	PRS	VPL	13	IR003	Eccentric Plug Valve	
4"	OC	PRS	VPL	14	IR003	Eccentric Plug Valve	
4"	**OC**	**PRS**	**VPL**	**15**	**IR003**	**Eccentric Plug Valve**	***Additive Alternative***
4"	**OC**	**PRS**	**VPL**	**16**	**IR003**	**Eccentric Plug Valve**	***Additive Alternative***
6"	OC	PRS	VPL	24	IR003	Eccentric Plug Valve	
6"	OC	PRS	VPL	24A	IR003	Eccentric Plug Valve	
6"	OC	PRS	VPL	24B	IR003	Eccentric Plug Valve	
6"	OC	PRS	VPL	24C	IR003	Eccentric Plug Valve	
8"	OC	PRS	VPL	25	IR003	Eccentric Plug Valve	
8"	OC	PRS	VPL	26	IR003	Eccentric Plug Valve	
8"	OC	PRS	VPL	27	IR003	Eccentric Plug Valve	
8"	OC	PRS	VPL	28	IR003	Eccentric Plug Valve	
36"	OC	WWP	VPL	190	IB005	Eccentric Plug Valve	
36"	OC	WWP	VPL	200	IB005	Eccentric Plug Valve	
36"	OC	WWP	VPL	210	IB005	Eccentric Plug Valve	
48"	OC	WWP	VPL	220	IB005	Eccentric Plug Valve	
48"	OC	WWP	VPL	230	IB005	Eccentric Plug Valve	
48"	OC	WWP	VPL	240	IB005	Eccentric Plug Valve	
48"	OC	WWP	VPL	250	IB005	Eccentric Plug Valve	
48"	OC	WWP	VPL	260	IB005	Eccentric Plug Valve	
36"	OC	SCR	VPL	160	IP001	Eccentric Plug Valve	
36"	OC	SCR	VPL	170	IP001	Eccentric Plug Valve	
24"	**OC**	**SCR**	**VPL**	**101**	**IF003**	**Eccentric Plug Valve - Motorized**	***Additive Alternative***
24"	**OC**	**SCR**	**VPL**	**102**	**IF003**	**Eccentric Plug Valve - Motorized**	***Additive Alternative***
24"	**OC**	**SCR**	**VPL**	**180**	**IF003**	**Eccentric Plug Valve**	***Additive Alternative***

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type
24"	OC	SCR	VPL	130	IF003	Eccentric Plug Valve

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings
2) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.
3) Valve Ends shall be as follows
   Flanged - in plant or vaulted
   Mechanical Joint - buried
4) Actuator types shall be as indicated on P&IDs drawings

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type	Type of Actuator	Stem Type

Notes:
1) Description of System and Fuction Codes can be found on the P&ID Drawings

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings
2) If any conflicts are found between this valve schedule and the PID drawings, the information on the PID drawings prevail

Pressure Relief Valve Schedule

Size	System Code	Function Code	Number	PID DRAWING	Valve Type
1"	FECL	VSP	10	IC009	Pressure Relief Valve
1"	FECL	VSP	11	IC009	Pressure Relief Valve
1"	FECL	VSP	12	IC009	Pressure Relief Valve

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings
2) If any conflicts are found between this valve schedule and the PID drawings, the information on the PID drawings prevail
3) These are specified in Section 11727 and shall be provided with the metering pump

Pressure Regulating Valve Schedule

Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type

Notes:

1) Description of System and Fuction Codes can be found on the P&ID Drawings

Diaphragm Valve Schedule

Serial Number	Size	Service	System Code	Function Code	Number	PID DRAWING	Valve Type

Section 15111

GATE INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the installation of new gates and actuators purchased.

The following specification sections are applicable to gates to be installed under this contract:

Section 11295

1-2. GENERAL. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Any gates and actuators identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

1-2.01. Coordination. When installation check services are provided by the gate manufacturer, Contractor shall coordinate the services with the gate manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's installation check services.

Submittals for equipment furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

PART 2 - PRODUCTS

2-1. MATERIALS. Materials shall be as follows:

Grout	As specified in the Grouting section.

PART 3 - EXECUTION

3-1. INSPECTION. All gates and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3-2. INSTALLATION.

3-2.01. General. Gates and appurtenances shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the gate for maintenance. Installation shall be in accordance with the manufacturer's recommendations and the requirements specified herein.

All bolts shall be tightened and all items requiring lubrication, including pivot pins, shall be lubricated. Anti-seize thread lubricant shall be liberally applied to the threaded portion of stainless steel anchor bolts during the installation and tightening of nuts. Excess lubricant shall be thoroughly removed following final tightening.

The threaded portion of each plastic stem cover shall be wrapped in at least two layers of teflon thread tape, and the threaded portion of steel pipe stem covers shall be coated with teflon thread sealer immediately prior to installation of the cover on the actuator.

Each gate shall be adjusted so that it does not bind or leak in excess of specified requirements. After installation, each gate shall be operated through at least two complete open-close cycles, re-adjusted and re-operated as necessary, and left in a condition acceptable to Engineer.

3-2.02. Installation Checks. When specified in the gate sections, the gate manufacturer will provide installation checks. For installation checks, the manufacturer’s field representative will inspect the gate installation immediately following installation by Contractor. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

Contractor shall perform no Work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.

3-2.03. Cast-Iron and Fabricated Stainless Steel Slide Gates. Not used.

3-2.05. Open-Channel coplastix Weir Gates. Each open-channel weir gate shall be carefully installed and adjusted for proper operation. Care shall be taken to avoid deformation of the gate frames and to maintain tolerances between seating faces.

Each embedded frame shall be carefully braced in the forms before concrete is placed, or a space shall be boxed out and the frame shall be grouted in place later. Care shall be exercised to ensure that frame members and anchor bolts do not rest upon or contact steel reinforcing bars.

Components of the coplastix weir gates installed in contact with concrete, shall be coated with epoxy in accordance with the Protective Coatings section prior to installation. Damaged areas of shop-applied coatings shall be re-coated and allowed to cure before placement of concrete or grout. Anchor bolts shall be carefully set using a template.

3-2.06. Flap Gates. Not used.

3-2.07. Tilting Weirs in Aeration Basins. Not used.

3-3. GATE ACTUATORS. Gate actuators and accessories shall be installed in accordance with the equipment manufacturer's recommendations.

3-4. FIELD QUALITY CONTROL.

3-4.01. Field Testing. After installation, all gates shall be pressure tested for leakage at the hydrostatic heads specified. Leakage exceeding the specified limits which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3-4.01.01. Cast-Iron Slide Gates. Not used.

3-4.01.02. Fabricated Stainless Steel Slide Gates. Not used.

3-4.01.03. Open-Channel Coplastix Weir Gates. For the maximum seating and unseating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.

3-5. ADJUSTING. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic, or electric actuated gate.

End of Section

Section 15140

PIPE SUPPORTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of pipe hangers, brackets, supports, bracing, anchorage, and the design for the pipe support system for pipes 12 inches and smaller. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories. This section also covers the spacing of expansion joints in pipes 12 inches in diameter and smaller. Expansion joint products and materials are covered in the respective piping sections.

This section covers pipe supports for the following pipe materials:

Cast or ductile iron

Stainless Steel
Hot-dip galvanized steel
Steel (hot water)
Steel (other)
Copper (hot water)
Copper (other)
PVC/CPVC Schedule 80 (chemical service)
PVC/CPVC Schedule 80 (other)
PVC Schedule 40
FRP (pressure)
FRP (low pressure)

1-2. GENERAL. Contractor shall provide pipe supports, anchors, flexible couplings, and expansion joints for all piping systems. The Drawings indicate pipe supports, anchors, flexible couplings, and expansion joints for pipes larger than 12 inches in diameter, and in special cases for pipes that are 12 inches and smaller. Contractor shall design anchors, pipe supports, expansion joints, and flexible couplings not already shown on the Drawings, in accordance with the requirements specified herein.

Contractor's design shall include pipe supports, bracing, and anchorage adjacent to expansion joints, couplings, valves, in-line devices, equipment, wyes and tees, or changes in direction as required for dismantling piping, removing valves or other in-line devices, disconnecting piping from equipment, and pipe support, in addition to supports in accordance with the maximum spacing specified herein. The pipe support system design by Contractor shall rigidly support pipe so there

is no visible movement or visible sagging between supports. The system shall comply with specified piping code requirements.

Contractor shall not delete or relocate the supports, expansion joints, or couplings indicated on the Drawings without written approval of Engineer.

Pipe supports and expansion joints are not required in buried piping, but concrete blocking or other suitable anchorage shall be provided as indicated on the Drawings or specified in other sections.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all supports furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-3. SUBMITTALS. Complete data, catalog information, and drawings covering fabricated pipe supports, fabricated inserts, and stainless steel, galvanized, and copper-plated and plastic-coated pipe supports shall be submitted in accordance with the Submittals Procedures section.

Data shall include a listing of the intended use and general location of each item submitted.

When a wind and/or seismic design is required, Contractor shall submit confirmation of compliance with the Meteorological and Seismic Design Criteria section.

PART 2 - PRODUCTS

2-1. MATERIALS. Unless otherwise indicated, all pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69. Materials of construction for fabricated steel supports are covered in the Structural and Miscellaneous Metals section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.

Unless otherwise specified or indicated on the Drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.

Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

Pipe supports shall be manufactured for the sizes and types of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have

sufficient threading to permit the maximum adjustment available in the support item. Continuously threaded rod is not acceptable for hanger rods over 12 inches [300 mm] in length.

Unless accepted by Engineer, the use of supports which rely on stressed thermoplastic components to support the pipe will not be permitted.

Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated. Supports for brass or copper pipe or tubing shall be copper plated or plastic coated.

Stainless steel supports shall be AISI Type 316 stainless steel, except for stainless steel supports fabricated by welding which shall be AISI Type 316L. Stainless steel supports shall be provided in all project locations, unless otherwise noted on the drawings..

Hot-dip galvanized supports shall be in accordance with ASTM A153 and A385. Galvanized supports shall be provided in places only indicated on the drawings.

Pipe support types and application shall comply with Table 1.

2-2. WIND AND SEISMIC LOADS. Wind and seismic loads for worst case conditions of either full, partially full, or empty pipes shall be considered in the design. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

PART 3 - EXECUTION

3-1. APPLICATION. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Fastening of supports to existing concrete and masonry shall be in accordance with the Anchorage in Concrete and Masonry section.

Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as specified to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as needed to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.

When expansion joints are required, pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required where mechanical couplings are permitted as expansion joints. Guides shall be located on both sides of expansion joints, except where anchors are adjacent to the joint. Unless otherwise indicated on the Drawings, one guide shall be within four pipe diameters from the joint and a second guide within 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for anchoring pipe against longitudinal forces. Pipe guides shall be provided at locations as recommended by the manufacturer.

Pipe supports for insulated cold piping systems shall be sized for the outside diameter of the insulated pipe, and an insulation protection shield shall be installed between the support and the insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields for piping larger than 2 inches [50 mm] or when needed to prevent crushing of the insulation. Inserts shall be of the same thickness as the adjacent insulation and shall be vapor sealed.

Insulated hot piping systems shall be supported by clevises, clamps, support saddles, or rollers. Pipe clamps shall be attached directly to the pipe. Support saddles and rollers shall be sized for the outside diameter of the insulated pipe, and an insulation protection saddle shall be installed at the support.

When supports for the FRP piping systems are in contact with less than 180 degrees of the pipe surface or when the width of the support is less than one-third the nominal pipe diameter (4 inches [100 mm] minimum), an FRP or steel saddle, shaped to the outside diameter of the pipe, shall be bonded to at least the bottom 120 degrees of the pipe.

3-2. TYPES OF SUPPORTS. The products for pipe supports shall be as indicated in Table 1 for the specified type and size of support. Where stainless steel is specified for pipe supports but is not available from the name suppliers for the model specified in Table 1, Contractor shall provide a heavier duty support that is available in stainless steel.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
Hangers		
2-1/2 inch [63 mm] and smaller pipe		
For hot and cold insulated piping		

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
Clevis	1	B-Line "B3100", Anvil "260" Piping Technology & Products Fig. 83.
Other services		
J-style	5	B-Line "B3690", Anvil "67", Unistrut "J Hanger", or Piping Technology & Products Fig. 67.
Clevis	1	B-Line "B3104", Anvil "260", or Piping Technology & Products Fig 83.
3 Through 12 inch [75 through 300 mm] pipe (Note 3)		
For hot insulated piping		
Double bolt	3	B-Line "B3144", Anvil "295", or Piping Technology & Products Fig. 70.
For cold insulated piping		
Clevis	1	B-Line "B3100", Anvil "260", or Piping Technology & Products Fig 83 .
For uninsulated cold piping		
Clamp	4	B-Line "3140", Anvil "212", or Piping Technology & Products Fig. 50.
Clevis	1	B-Line "B3100", Anvil "260", or Piping Technology & Products Fig 83.
Other services		
Clevis	1	B-Line "B3100" or Anvil "260" for steel pipe; B-Line "B3102", Anvil "590", or Piping Technology & Products Fig. 83 C. L. for cast iron pipe.
Concrete Inserts, Steel		

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
12 inch [300 mm] and smaller pipe	18	Channel 12 ga [2.66 mm thick], galv, 1-5/8 by 1-3/8 inches [41.3 by 34.9 mm], min. 8 inches [200 mm] long, anchor lugs on 4 inch [100 mm] centers, at least three lugs, end caps, and filler strip.
Beam Clamps, Malleable Iron or Steel, 12 inch [300 mm] and smaller pipe	21	B-Line "3050" and "3055", Anvil "133" and "134", or Piping Technology & Products Fig. 130 and Fig. 130 (SP).
	28, 29	Anvil "292" or Piping Technology & Products Fig. 140.
	30	B-Line "3054", Anvil "228", or Piping Technology & Products Fig. 140.
Side Beam Bracket	34	B-Line "B3062", Anvil "202", or Piping Technology & Products Fig. 20L.
Wall Supports and Frames, Steel, 12 inch [300 mm] and smaller pipe (Note 2)		
Brackets	32	B-Line "B3066", Anvil "195", or Piping Technology & Products Fig. 76.
	33	B-Line "B3067", Anvil "199", or Piping Technology & Products Fig. 76.
Prefabricated channels	--	12 ga [2.66 mm thick], galv, 1-5/8 inches [41.3 by 41.3 mm], with suitable brackets and pipe clamps.
Offset pipe clamp, 1-1/2 inch [38 mm] and smaller pipe	--	Galv, 1-1/4 by 3/16 inch [32 by 4.7 mm] steel, with 3/8 inch [9.5 mm] bolts.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
Offset pipe clamp, 2 to 3-1/2 inch [50 to 88 mm] pipe	--	Galv, 1-1/4 by 1/4 inch [32 by 6 mm] steel, with 3/8 inch [9.5 mm] bolts.
Floor Supports, Steel or Cast Iron		
6 inch [150 mm] and smaller pipe	37 (with base)	B-Line "B3090", Anvil "259" or Piping Technology & Products Fig. 48.
8 through 12 inch [200 to 300 mm] pipe	38	B-Line "B3093", Anvil "264" or Piping Technology & Products Fig. 46.
Pipe Alignment Guides	--	B-Line "B3281" through "B3287", Anvil "255", or Piping Technology & Products Fig. 6.
Turnbuckles Steel	13	B-Line "B3202", Anvil "230", or Piping Technology & Products Fig. 30.
Hanger Rods, Carbon Steel, Threaded Both Ends, 3/8 inch [10 mm] minimum size	--	B-Line "B3205", Anvil "140", or Piping Technology & Products Fig. 128.
Weldless Eye Nut, steel	17	B-Line "B3200", Anvil "290", or Piping Technology & Products Fig. 40.
Insulation Protection Saddle	39	B-Line "B3160 Series", Anvil "160 Series", or Piping Technology & Products Fig. 184.
Insulation Protection Shield	40	B-Line "B3151", Anvil "167", or Piping Technology & Products Fig. 183.

Table 1 Notes:

1. MSS SP-69 supports and hangers are illustrated on Figure 1-15140.
2. Pipe clamps or other devices which rely on the application of a clamping force to the supported pipe in order to maintain the clamp position or location in a prefabricated channel or track will not be acceptable for use with nonmetallic pipe or tubing.
3. Alternatively, pipe hangers for 12 inch pipe may be saddle type as indicated on the Drawings.

3-3. SUPPORT SPACINGS. Pipe supports and expansion joints shall be spaced in accordance with Tables 2, 3, 4, and 5. The types of pipes to be supported are as specified herein. Table 2 covers spacings for the standard operating conditions specified for each pipe material. Tables 3 and 4 cover PVC and FRP pipe spacings where operating conditions are in excess of the temperature and specific gravity requirements covered in Table 2. Table 5 covers PVC and FRP pipe which carries air or liquids with a specific gravity other than 1.0. Spacing in the tables is the maximum spacing considering gravity loads. Where Contractor's design includes lateral and longitudinal forces due to seismic loads, wind loads, and other forces, the spacing requirement may be less than that indicated in the tables.

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet [m]	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet [m]	Expansion Joint Max Spacing (Note 2) feet [m]	Type of Expansion Joints
Cast iron or Ductile iron	15 [4.5]	80 [24.4]	80 [24.4]	Note 6
Cast iron or Ductile iron, glass-lined	12 [3.6]	80 [24.4]	80 [24.4]	Note 6
Steel, for hot water heating				
1-1/4 inch [31 mm] and smaller	7 [2.1]	30 [9.1]	100 [30.5]	Note 3
1-1/2 to 4 inch [38 to 100 mm]	10 [3.0]	30 [9.1]	100 [30.5]	Note 3
Over 4 inch [100 mm]	15 [4.5]	30 [9.1]	100 [30.5]	Note 3
Steel, for other services				
1-1/4 inch [31 mm] and smaller	7 [2.1]	30 [9.1]	100 [30.5]	Note 3
1-1/2 to 4 inch [38 to 100 mm]	10 [3.0]	30 [9.1]	100 [30.5]	Note 3
Over 4 inch [100 mm]	15 [4.5]	80 [24.4]	80 [24.4]	Note 6
Stainless steel				

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet [m]	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet [m]	Expansion Joint Max Spacing (Note 2) feet [m]	Type of Expansion Joints
1-1/4 inch [31 mm] and smaller	7 [2.1]	30 [9.1]	100 [30.5]	Note 3
1-1/2 to 4 inch [38 to 100 mm]	10 [3.0]	30 [9.1]	100 [30.5]	Note 3
Over 4 inch [100 mm]	15 [4.5]	80 [24.4]	80 [24.5]	Note 3
Copper, for hot water				
1 inch [25 mm] and smaller	5 [1.5]	20 [6.1]	100 [30.5]	Note 3
Over 1 inch [25 mm]	7 [2.1]	20 [6.1]	100 [30.5]	Note 3
Copper, for services other than hot water				
1 inch [25 mm] and smaller	5 [1.5]	--	--	Note 7
Over 1 inch [25 mm]	7 [2.1]	50 [15.2]	100 [30.5]	Note 3
PVC, Schedule 80, for alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution at a maximum temperature of 100°F [38°C].				
1/8 and 1/4 inch [3 and 6 mm]	Continuous Support	20 [6.1]	60 [18.3]	Note 3
1/2 inch [13 mm]	3-1/2 [1]	20 [6.1]	60 [18.3]	Note 3
3/4 inch [19 mm]	4 [1.2]	20 [6.1]	60 [18.3]	Note 3
1 and 1-1/4 inch [25 and 31 mm]	4-1/2 [1.3]	20 [6.1]	60 [18.3]	Note 3
1-1/2 and 2 inch [38 and 50 mm]	5 [1.5]	20 [6.1]	60 [18.3]	Note 3

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet [m]	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet [m]	Expansion Joint Max Spacing (Note 2) feet [m]	Type of Expansion Joints
2-1/2 inch [63 mm]	5-1/2 [1.6]	20 [6.1]	60 [18.3]	Note 3
3 inch [75 mm]	6-1/2 [1.9]	20 [6.1]	60 [18.3]	Note 3
4 inch [100 mm]	7 [2.1]	20 [6.1]	60 [18.3]	Note 3
6 inch [150 mm]	8 [2.4]	20 [6.1]	60 [18.3]	Note 3
8 inch [200 mm]	9 [2.7]	20 [6.1]	60 [18.3]	Note 3
10 inch [250 mm]	9-1/2 [2.9]	20 [6.1]	60 [18.3]	Note 3
12 inch [300 mm]	10 [3.0]	20 [6.1]	60 [18.3]	Note 3
PVC, Schedule 80, for other services at a maximum temperature of 100°F [38°C] and a maximum specific gravity of 1.0.				
1/8 and 1/4 inch [3 and 6 mm]	Continuous Support	20 [6.1]	60 [18.3]	Note 3
1/2 inch [13 mm]	4 [1.2]	20 [6.1]	60 [18.3]	Note 3
3/4 inch [19 mm]	4-1/2 [1.3]	20 [6.1]	60 [18.3]	Note 3
1 and 1-1/4 inch [25 and 31 mm]	5 [1.5]	20 [6.1]	60 [18.3]	Note 3
1-1/2 and 2 inch [38 and 50 mm]	5-1/2 [1.6]	20 [6.1]	60 [18.3]	Note 3
2-1/2 inch [63 mm]	6 [1.8]	20 [6.1]	60 [18.3]	Note 3
3 inch [75 mm]	7 [2.1]	20 [6.1]	60 [18.3]	Note 3
4 inch [100 mm]	7-1/2 [2.3]	20 [6.1]	60 [18.3]	Note 3

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet [m]	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet [m]	Expansion Joint Max Spacing (Note 2) feet [m]	Type of Expansion Joints
6 inch [150 mm]	8-1/2 [2.6]	20 [6.1]	60 [18.3]	Note 3
8 inch [200 mm]	9-1/2 [2.8]	20 [6.1]	60 [18.3]	Note 3
10 inch [250 mm]	10 [3.0]	20 [6.1]	60 [18.3]	Note 3
12 inch [300 mm]	11 [3.3]	20 [6.1]	60 [18.3]	Note 3
FRP, for double containment and single wall pressure pipe at a temperature of 150°F [66°C].				
1 inch [25 mm]	3-1/2 [1]	60 [18.3]	100 [30.5]	Note 3
1-1/2 inch [38 mm]	4 [1.2]	60 [18.3]	100 [30.5]	Note 3
2 inch [50 mm]	5 [1.5]	60 [18.3]	100 [30.5]	Note 3
3 inch [75 mm]	5-1/2 [1.6]	60 [18.3]	100 [30.5]	Note 3
4 inch [100 mm]	6 [1.8]	40 [12.2]	100 [30.5]	Note 3
6 inch [150 mm]	7 [2.1]	40 [12.2]	100 [30.5]	Note 3
8 inch [200 mm]	8 [2.4]	40 [12.2]	100 [30.5]	Note 3
10 inch [250 mm]	8-1/2 [2.6]	40 [12.2]	100 [30.5]	Note 3
12 inch [300 mm]	9 [2.7]	40 [12.2]	100 [30.5]	Note 3
FRP, for low pressure and odor control pipe at a maximum temperature of 150°F [66°C] and a maximum specific gravity of 1.0.				
1 inch [25 mm]	4 [1.2]	60 [18.3]	100 [30.5]	Note 3
1-1/2 inch [38 mm]	4-1/2 [1.3]	60 [18.3]	100 [30.5]	Note 3
2 inch [50 mm]	5-1/2 [1.6]	60 [18.3]	100 [30.5]	Note 3

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet [m]	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet [m]	Expansion Joint Max Spacing (Note 2) feet [m]	Type of Expansion Joints
3 inch [76 mm]	6 [1.8]	60 [18.3]	100 [30.5]	Note 3
4 inch [100 mm]	6-1/2 [2]	40 [12.2]	100 [30.5]	Note 3
6 inch [150 mm]	7-1/2 [2.3]	40 [12.2]	100 [30.5]	Note 3
8 inch [200 mm]	8-1/2 [2.6]	40 [12.2]	100 [30.5]	Note 3
10 inch [250 mm]	9-1/2 [2.8]	40 [12.2]	100 [30.5]	Note 3
12 inch [300 mm]	10 [3.0]	40 [12.2]	100 [30.5]	Note 3
PVC, Schedule 40, for services at a maximum temperature of 100°F [38°C], and a maximum specific gravity of 1.0.				
1/8 and 1/4 inch [3 and 6 mm]	Continuous Support	20 [6.1]	60 [18.3]	Note 3
1/2 inch [13 mm]	3-1/2 [1.0]	20 [6.1]	60 [18.3]	Note 3
3/4 and 1 inch [19 and 25 mm]	4 [1.2]	20 [6.1]	60 [18.3]	Note 3
1-1/4 and 1-1/2 inch [31 and 38 mm]	4-1/2 [1.3]	20 [6.1]	60 [18.3]	Note 3
2 inch [50 mm]	5 [1.5]	20 [6.1]	60 [18.3]	Note 3
2-1/2 inch [63 mm]	5-1/2 [1.6]	20 [6.1]	60 [18.3]	Note 3
3 inch [75 mm]	6 [1.8]	20 [6.1]	60 [18.3]	Note 3
4 inch [100 mm]	6-1/2 [1.9]	20 [6.1]	60 [18.3]	Note 3
6 inch [150 mm]	7-1/2 [2.2]	20 [6.1]	60 [18.3]	Note 3

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet [m]	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet [m]	Expansion Joint Max Spacing (Note 2) feet [m]	Type of Expansion Joints
8 inch [200 mm]	8 [2.4]	20 [6.1]	60 [18.3]	Note 3
10 inch [250 mm]	8-1/2 [2.5]	20 [6.1]	60 [18.3]	Note 3
12 inch [300 mm]	9-1/2 [2.9]	20 [6.1]	60 [18.3]	Note 3

Table 2 Notes:

1. Unless otherwise acceptable to Engineer, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.
2. Unless otherwise acceptable to Engineer, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.
3. Expansion joint fittings are specified in the respective piping sections.
4. At least two properly padded supports for each pipe section.
5. At least one support for each pipe section.
6. Expansion joints shall be mechanical couplings.
7. No expansion joints are required.
8. Supports for 5 and 10 foot [1.5 and 3 m] long pipe sections shall be located within 18 inches [460 mm] of each joint. Supports shall be positioned to maintain the piping alignment and to prevent the piping from sagging.
9 References to specific gravity refer to liquid specific gravity and are referenced to water which is assumed to have a specific gravity of 1.0.

3-3.01. Temperature Adjustments for PVC Pipe. PVC pipe at a temperature above 100°F [38°C] shall have maximum support spacing in accordance with the following table. For insulated lines, reduce the support spacing to 70 percent of the listed values.

TABLE 3 – MAXIMUM PIPE SUPPORT SPACING FOR PVC PIPE AT NON-STANDARD TEMPERATURES
feet [meters]

Nominal Size inches [mm]	Schedule 40		Schedule 80	
	120°F [49°C]	140°F [60°C]	120°F [49°C]	140°F [60°C]
1/4 [6]	Continuous Support		Continuous Support	
1/2 [13]	3 [0.9]	2-1/2 [0.7]	3-1/2 [1.0]	3 [0.9]
3/4 [19]	3-1/2 [1.0]	3 [0.9]	4 [1.2]	3 [0.9]
1 [25]	3-1/2 [1.0]	3 [0.9]	4-1/2 [1.3]	3-1/2 [1.0]
1-1/4 [31]	4 [1.2]	3-1/2 [1.0]	4-1/2 [1.3]	4 [1.2]
1-1/2 [38]	4 [1.2]	3-1/2 [1.0]	5 [1.5]	4 [1.2]
2 [50]	4-1/2 [1.3]	3-1/2 [1.0]	5 [1.5]	4-1/2 [1.3]
2-1/2 [63]	4-1/2 [1.3]	4 [1.2]	5-1/2 [1.6]	4-1/2 [1.3]
3 [75]	5 [1.5]	4 [1.2]	6 [1.8]	5 [1.5]
4 [100]	5-1/2 [1.6]	4-1/2 [1.3]	6-1/2 [1.9]	5-1/2 [1.6]
6 [150]	6-1/2 [1.9]	5 [1.5]	8 [2.4]	6-1/2 [1.9]
8 [200]	7 [2.1]	5-1/2 [1.6]	8-1.2 [2.5]	7 [2.1]
10 [250]	7-1/2 [2.2]	6 [1.8]	9 [2.7]	7-1/2 [2.2]
12 [300]	8 [2.4]	6-1/2 [1.9]	10 [3.0]	8-1/2 [2.5]

3-3.02. Temperature Adjustments for FRP Pipe. FRP pipe at a temperature above and below 150°F [66°C] shall have maximum support spacing in accordance with the following table.

TABLE 4 – MAXIMUM PIPE SUPPORT SPACING FOR FRP PIPE AT NON-STANDARD TEMPERATURES
feet [meters]

Nominal Size inches [mm]	Temperature		
	75°F [24°C]	175°F [79°C]	200°F [93°C]
1 [25]	5 [1.5]	3 [0.9]	2 [0.6]
1-1/2 [38]	6 [1.8]	3-1/2 [1.0]	2-1/2 [0.7]
2 [50]	7 [2.1]	4 [1.2]	3 [0.9]
3 [75]	7-1/2 [2.2]	4-1/2 [1.3]	3-1/2 [1.0]
4 [100]	8 [2.4]	5 [1.5]	4 [1.2]
6 [150]	10 [3.0]	6 [1.8]	4-1/2 [1.3]
8 [200]	11 [3.3]	6-1/2 [1.9]	5 [1.5]
10 [250]	12-1/2 [3.8]	7-1/2 [2.2]	5-1/2 [1.6]
12 [300]	13 [3.9]	8 [2.4]	6 [1.8]

3-3.03. Specific Gravity Adjustments for PVC and FRP Pipe. PVC and FRP pipe shall have the maximum spacing indicated in Tables 2, 3, and 4 adjusted in

accordance with the following table when the specific gravity of the liquid is greater than 1.0. (Note: Specific gravities listed are liquid specific gravities referenced to water which is assumed to have a specific gravity of 1.0.) Table 5 shall not apply to PVC pipe containing alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution, as these services are specifically covered in Table 2.

Table 5 shall be used for chemical feed and odor control air piping, except for pipe containing alum, caustic soda, ferric chloride, or hypochlorite solutions (in Table 2).

TABLE 5 – MAXIMUM SUPPORT SPACING CORRECTION FACTORS FOR PVC AND FRP PIPE

Specific Gravity	Correction Factor
1.0	1.00
1.1	0.98
1.2	0.96
1.4	0.93
1.6	0.90
2.0	0.85
2.5	0.80
Air	1.40

3-4. INSTALLATION.

3-4.01. General. All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, and adjacent to flexible couplings. Pipe supports and hangers shall not be installed in equipment access areas.

Where horizontal piping is arranged with two or more parallel lines, trapeze hangers may be used in lieu of individual hangers. Trapeze assembly shall consist of structure attachments as previously specified with rod size dependent upon total weight supported. Spacing of assemblies shall be determined by the minimum pipe size included in the group supported. Trapeze horizontal assemblies shall be structural angle or channel section of sufficient size to prevent measurable sag between rods when pipes are full. All lines shall be attached to the horizontal with intermediate pipe guides and U-bolts or one-hole clamps. Pre-engineered support equipment may be used when selected and installed in accordance with the manufacturer's recommendations.

Where copper pipe is installed on a support system of dissimilar metal with other pipes, the copper pipe shall be galvanically isolated from the support using Neoprene strips or other material acceptable to Engineer.

No piping shall be supported from the pipe above.

Horizontal piping hanger support rods shall attach to steel beams with center-loading I-clamps, or welded beam clips. Hanger support rods shall attach to concrete slabs or beams with inserts.

Anchorage shall be provided to resist both lateral and longitudinal seismic forces.

3-4.02. Inserts. Reference building structural concrete Drawings for concrete inserts. When not provided as part of the building concrete structure, provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

Where concrete slabs form finished ceilings, provide inserts flush with the slab surface.

Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. NDE (Non-Destructive Evaluation) shall be used to locate existing reinforcing before drilling.

3-4.03. Pipe Hangers and Supports. Hanger rod sizes for copper pipe and plastic pipe shall be the size of hanger rods for steel pipe. Install hangers to provide a minimum 1/2 inch [13 mm] space between finished covering and adjacent work.

A hanger shall be placed within 18 inches [450 mm] of each horizontal elbow, and on both sides of all piping accessories and valves weighing 20 lbs [9 kg] or more.

Hangers shall have 1-1/2 inches [38 mm] minimum vertical adjustment.

Support horizontal cast iron, ductile iron and no-hub piping systems adjacent to each joint. Support vertical piping at every floor using riser clamps. Support riser piping independently of connected horizontal piping.

Hanger and hanger components shall be sized specifically for the pipe size it is to be used on.

3-5. PLACEMENT. The maximum spacing for pipe supports and expansion joints shall be as indicated in Tables 2, 3, 4, and 5.

Rubber hose and flexible tubing shall be provided with continuous angle or channel support.

Unless otherwise indicated on the Drawings or acceptable to Engineer, piping shall be supported approximately 1-1/2 inches [38 mm] out from the face of walls and at least 3 inches [75 mm] below ceilings.

End of Section

Section 15150

WATER METERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of water meters and associated appurtenances.

Pipe materials, valves, insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Meters specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication, assembly and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.
Type and model.
Construction materials, thicknesses, and finishes.
Performance curves indicating flow capacity versus pressure drop.
Accuracy.
Pressure and temperature ratings.
Overall dimensions.
Piping connection sizes and locations.
Net weight.
Wiring diagrams.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be submitted as required in the Submittals Procedures section.

1-4. QUALITY ASSURANCE.

1-4.01. Construction. Water meters shall be constructed in accordance with the following standards:

Displacement Water Meters	AWWA C700
Turbine Water Meters	AWWA C701
Compound Water Meters	AWWA C702
Propeller Water Meters	AWWA C704

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Water meters shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Water meters shall be designed to meet the performance and design conditions indicated herein, on the Drawings, and on the water meter schedule.

Each meter shall measure the actual flow within the accuracy specified over the indicated flow range with a water temperature range of 32 ^{o}F [0^{o} C] to 120 ^{o}F [50^{o} C]. The accuracy shall be expressed as a percentage of the actual flow and not as a percent of maximum flow.

Meter assemblies shall have performance capabilities of continuous operation up to the rated maximum flows without affecting long-term accuracy or causing any undue component wear. All meter assemblies shall also have a 25% flow capacity in excess of the maximum flows listed for intermittent flow demands.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. DESIGN AND CONSTRUCTION.

2-4.01. Displacement Meters. Displacement meters shall be nutating or oscillating disc type with bronze or synthetic polymer housing as indicated in the schedules, thermoplastic plastic chamber and hard rubber disc. Accuracy shall be ± 1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32 ^{o}F [0^{o} C] to 120 ^{o}F [50^{o} C] and a working pressure of 150 psi [1,050 kPa]. Each meter shall be provided with threaded union type spud end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Displacement type meters shall be Badger Meter Inc., "Recordall Disc Meter" or ABB Water Meters, Inc.

2-4.02. Turbine Meters. Turbine meters shall be moving rotor type with bronze, cast iron, or 316 stainless steel housing as indicated in the schedules, thermoplastic rotor, ceramic bearings, stainless steel straightening vanes, Buna N "O" ring, and Nitrile head gasket. Accuracy shall be ± 1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32 ^{o}F [0^{o} C] to 120 ^{o}F [50^{o} C] and a working pressure of 150 psi [1,050 kPa]. Meters in 2 inch and smaller sizes shall be provided with threaded union type spud end connections. Meters in larger than 2 inch sizes shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Turbine type meters shall be Badger Meter Inc., "Recordall Turbo Meter" or ABB Water Meters, Inc.

2-4.03. Compound Meters. Compound meters shall incorporate a positive displacement chamber for measuring low flows, a turbine chamber for measuring high flows, and a valve for diverting flow to the respective chamber. Compound meters shall be provided with a single housing or may be provided with independent housings factory piped with a single inlet and outlet connection. Meters shall be provided with bronze housings and piping, thermoplastic rotor, valve casing, and disc chamber, and stainless steel straightening vanes. Accuracy shall be ± 1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32 ^{o}F [0^{o} C] to 120 ^{o}F [50^{o} C] and a working pressure of 150 psi [1,050 kPa]. Meters shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Compound type meters shall be Badger Meter Inc., "Recordall Compound Meter", or ABB Water Meters, Inc.

2-4.04. Propeller Meters. Propeller meters shall be rotating propeller type with cast iron housing, copper stabilized polypropylene propeller, graphite/stainless steel propeller bearing, graphite/carbide thrust bearing, and stainless steel straightening vanes. Accuracy shall be ± 2.0 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32 ^{o}F [0^{o} C] to 120 ^{o}F [50^{o} C] and a working pressure of 150 psi [1,050 kPa]. Meters shall be provided with ANSI Class 125 flanged end connections.

Meter register shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Propeller type meters shall be AMCO "R1000 Propeller Meter", or Sparling Instruments, Inc.

2-5 PAINTING AND COATINGS.

2-5.01. Surface Preparation. All iron and steel surfaces shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint or coating manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2-5.02. Shop Painting. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Coatings located in water passages shall comply with AWWA requirements for use with potable water. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the painting section.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3-2. INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Meters shall be installed with the required upstream and downstream straight pipe lengths as recommended by the manufacturer.

3-3. ADJUSTING. Meters shall be calibrated and adjusted according to manufacturer's written instructions after installation. Meter faces shall be adjusted to proper angle for best visibility.

3-4. PROTECTION. Meters and appurtenances shall be protected from damage immediately after installation. Scratched, cracked or broken components shall be replaced. Meters shall not be used during the construction.

3-5. CLEANING. After completion of testing and immediately before the final inspection, meters shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer.

End of Section

Section 15180

VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing manual and powered valve and gate actuators and accessories as specified herein.

1-2. GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Governing Standards. Except as modified or supplemented herein, cylinder and vane type actuators shall conform to applicable requirements of ANSI/AWWA C541.

Except as modified or supplemented herein, electric motor actuators shall conform to applicable requirements of ANSI/AWWA C542.

Except as modified or supplemented herein, actuators for butterfly and eccentric plug valves shall conform to the applicable requirements of ANSI/AWWA C504.

Except as modified or supplemented herein, manual actuators for ball valves shall conform to the applicable requirements of ANSI/AWWA C507.

Except as modified or supplemented herein, actuators for cast-iron slide gates shall conform to the applicable requirements of ANSI/AWWA C560.

Except as modified or supplemented herein, actuators for open channel slide gates and weir gates shall conform to the applicable requirements of ANSI/AWWA C513.

Except as modified or supplemented herein, actuators for stainless steel slide gates shall conform to the applicable requirements of ANSI/AWWA C561.

Except as modified or supplemented herein, actuators for composite slide gates shall conform to the applicable requirements of ANSI/AWWA C563.

1-2.03. Power Supply. Power supply to electric actuators will be 480VAC, 3-phase.

1-2.04. Marking. Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.

1-2.05. Temporary Number Plates. Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve or gate by number or service as indicated in the valve or gate schedule.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.

Submittal drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.

For electric or cylinder actuators, certified copies of reports covering proof-of-design testing of the actuators as set forth in Section 5 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, together with an affidavit of compliance as indicated in Section 6.3 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, shall be submitted to Engineer before the actuators are shipped.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS.

2-1.01. General. Actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective valve and gate sections.

Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.

2-1.02. Valve Actuators. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential across the valve and maximum velocities through the valve where indicated in the respective valve schedules.

Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the Drawings or directed by Engineer.

When valves are to be buried, submerged, or installed in vaults; the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective valve schedules but not less than 20 feet [6.1 m].

2-1.03. Gate Actuators. Actuators shall be sized to produce the torque or thrust required to operate the gate when subject to the seating and unseating operating heads as indicated in the respective gate schedules.

Both the design head and the operating head shall be measured from the surface of the liquid to the center line of the gate.

2-1.04. Limit Switches. Limit switches shall be provided as indicated on the Drawings or in the valve and gate schedules.

For manual or cylinder type actuators, each limit switch shall be heavy duty type, with a cast NEMA Type 4 enclosure, a spring return roller lever, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts ac and 5 amperes at 125 volts dc. The switches shall be Allen Bradley "802T" or Square D "9007 Type C".

Limit switches for intelligent and standard electric actuators shall be as indicated in their respective paragraphs.

2-2. MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of the applicable governing standard(s).

2-3. VALVE MANUAL ACTUATORS.

2-3.01. General. Manual actuators of the types listed in the valve specifications or schedules shall be provided by the valve manufacturer.

Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

Actuators shall produce the required torque with a maximum pull of 80 lbs [356 N] on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs [890 N] on the handwheel or chainwheel or an input of 300 foot-lbs [407 J] on the operating nut.

2-3.02. Handwheels. Handwheel diameters shall be at least 8 inches [200 mm] but not more than 24 inches [600 mm] for 30 inch [750 mm] and smaller valves and not more than 30 inches [750 mm] for 36 inch [900 mm] and larger valves.

2-3.03. Chainwheels. Unless otherwise specified in the valve schedules, all valves with center lines more than 7'-6" [2.3 m] above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized or zinc plated carbon steel and shall be looped to extend to within 4 feet [1.2 m] of the floor below the valve.

2-3.04. Levers. Levers shall be capable of being locked in at least five intermediate positions between fully open and fully closed. In any building or structure containing lever operated valves, at least two operating levers shall be provided for each size and type of lever operated valve.

2-3.05. Chain Levers. Suitable actuator extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains

shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet [1.2 m] of the floor below the valve.

2-3.06. Wrench Nuts. Unless otherwise specified in the valve schedules or on the Drawings, wrench nuts shall be provided on all buried valves and on all valves that are to be operated through floor boxes. Unless otherwise directed by Owner, all wrench nuts shall comply with Section 4.4.13 of ANSI/AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

2-3.07. Operating Stands. Operating stands shall be provided in the locations indicated on the Drawings or as indicated in the valve and gate schedules. Operating stands shall support the handwheel approximately 36 inches [900 mm] above the floor. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand. When stems are 10 feet [3 m] or longer, a suitable thrust bearing shall be provided in each operating stand to carry the weight of the extension stem.

2-3.08. Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the Drawings or in the respective valve schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2-4. GATE MANUAL ACTUATORS.

2-4.01. General. Manual actuators of the types listed in the gate schedules shall be provided by the gate manufacturer. Unless otherwise specified, actuators shall conform to ANSI/AWWA C560.

All bearings and gears shall be totally enclosed in a weathertight housing having a sufficient number of fittings to permit periodic lubrication of all internal moving components without partial or total disassembly of the mechanism. The pinion shaft of crank-operated mechanisms shall be supported by roller bearings or needle bearings.

The direction of rotation of the wheel, crank, or wrench nut to open the gate shall be to the left (counterclockwise).

Actuators for rising stem self-contained gates shall be designed for mounting directly on the frame yoke.

When indicated in the gate schedules, crank-operated actuators shall be suitable for operation with a portable actuator specified herein. A suitable adapter coupling shall be furnished with each crank actuator to couple the portable actuator to the crank actuator pinion shaft as required.

2-4.02. Remote Actuators. Not used.

2-4.03. Dual Actuators. Dual actuators shall be provided where indicated in the gate schedules. Dual actuators shall be interconnected by a cross shaft complete with required couplings so both stems move at the same rate. Each cross shaft shall be protected by a full length removable aluminum or stainless steel cover attached to the yoke beam or actuator.

2-4.04. Floorstands. Floorstands shall be designed to transfer operating thrusts to the supporting structure. Each floorstand shall be designed to position the crank or the handwheel approximately 36 inches [900 mm] above the frame yoke, supporting surface, or adjacent operating floor or platform.

2-4.05. Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the Drawings or indicated in the respective gate schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2-4.06. Stem Covers. Rising stem manual actuators shall be provided with a stem cover as indicated in the gate schedules. Stem covers shall conform to Section 4.4 of ANSI/AWWA C560.

2-4.06.01. Plastic Covers. Covers shall be constructed of transparent plastic pipe and shall be furnished with an end cap, condensation vents, and a clear mylar position-indicating marking tape. The marking tape shall be adhesive backed and shall be permanently marked and calibrated in feet and inches [meters and millimeters]. The tape shall be applied to the stem cover after the gate has been installed and shall be so positioned that the height of the slide will be indicated by reference to the top of the stem.

2-4.06.02. Steel Covers. Covers shall be constructed from steel pipe and shall be furnished complete with a threaded end cap. All steel components of each cover shall be hot-dip galvanized following fabrication.

The operating mechanism shall be furnished with a digital or dial type mechanical position indicator. The indicator mechanism shall be installed inside a weatherproof housing and shall be clearly visible through a transparent, weatherproof window.

2-5. INTELLIGENT ELECTRIC ACTUATORS.

2-5.01. General. Intelligent electric actuators as listed in the valve and gate schedules shall be provided by the valve or gate manufacturer.

Intelligent electric actuators with torque output requirements of 750 ft-lbs and less for butterfly valves and eccentric plug valves shall be quarter-turn type and shall be Auma "AUMATIC SGBV 05.1 through SGBV 12.1", EIM “HQ Series”, Limitorque "QX" without exception.

All other intelligent electric actuators for open-close service shall be multi-turn type and shall be Auma “AUMATIC AC SABV 07.1 through SABV 16.1”, EIM “TEC2000”, Limitorque "MX", without exception.

Intelligent electric actuators for modulating service shall be Auma “AUMATIC AC SARBV 07.1 through SARBV 16.1”, EIM “TEC2000”, Limitorque “MX”, without exception.

Intelligent electric actuators for explosion proof service shall be Auma “AUMATIC AC SAExBV/SARExBV 07.1 through SAExBV/SARExBV 16.1”, EIM “TEC2000”, Limitorque “MX”, without exception.

Intelligent electric actuators produced by other manufacturers are not acceptable.

Intelligent electric actuators shall be capable of non-intrusive configuration without requiring removal of any actuator covers. Configuration of actuator functions shall be by use of a hand held infrared linked device, laptop or PDA with compatible wireless communication capability, or by local control switches and 32-character LCD display mounted on the actuator housing. The display language shall be English .

Intelligent electric actuators shall be provided with the capability to connect to a network over which valve commands and status shall be communicated. The actuator shall have been tested and certified for the latest version of this protocol to insure proper operation with the polling device.

Each intelligent electric actuator shall be furnished complete with a motor, gearing, handwheel, configurable output relays, torque sensors, lubricants, wiring, and terminals. Each actuator shall be constructed as a self-contained unit with a ductile iron or aluminum alloy housing, of a type as indicated in the valve and gate schedules, and shall be integrally assembled on the applicable valve or gate by the valve or gate manufacturer. Housings shall have two O-ring seals, one on the controls compartment and one on the terminal cover.

Actuators shall be designed to cycle the valve or gate from the fully open to the fully closed position or the reverse in approximately 60 seconds or as indicated in the valve and gate schedules.

Actuator motors may be mounted horizontally adjacent to or vertically above the reduction gearing. All gearing shall be oil or grease lubricated.

2-5.02. Motors. Motors shall be totally enclosed, high torque design made expressly for valve and gate actuator service, capable of operating the valve or gate under full differential pressure for two complete strokes or one complete cycle of travel without overheating. Motors shall be designed in accordance with NEMA standards and shall operate successfully at any voltage within 10 percent above or below rated voltage. Motor bearings shall be permanently lubricated. Motors shall be provided with stall, temperature, loss of phase, and reverse phase protection. Actuators shall be capable of indicating phase loss.

2-5.03. Power Gearing. Power gearing shall consist of hardened steel spur or helical gears and alloy bronze or hardened steel worm gear, all suitably lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter. Steel gears shall be hardened to at least 350 Brinell. Planetary or cycloidal gearing, aluminum, mild steel, or nonmetallic gears will not be acceptable. Gearing shall be designed to be self-locking so that actuation of a torque switch or electronic torque protection device by a torque overload condition will not allow the actuator to restart until the torque overload has been eliminated. If a secondary gearbox is required, it shall be designed to withstand the locked rotor torque of the actuator.

2-5.04. Handwheel Mechanism. The handwheel shall not rotate during motor operation. During handwheel operation the motor shall not affect the actuator operation. The actuator shall be responsive to electrical power and control at all times and, when under electrical control, shall instantly disengage the handwheel. The handwheel shall rotate counterclockwise to open the valve. An arrow indicating the opening direction and the word "Open" shall be cast on the handwheel. The force required to operate the handwheel shall not exceed 80 lbs [350 N]. The handwheel shall have a padlockable declutch lever.

2-5.05. Torque Sensing. Torque and thrust loads in both closing and opening directions shall be limited by a torque sensing device. Torque settings shall be adjustable and shall be indicated locally. The adjustment shall permit a variation of 40 to 100 percent of rated torque.

2-5.06. Terminal Facilities. Terminal facilities for connection to motor leads, switches, and control and indication signals shall be provided in a readily accessible terminal compartment. The terminal compartment shall have at least two openings for external electrical conduits, one sized at least 3/4 inch [19 mm] and the other at least 1-1/4 inches [31 mm]. Each terminal compartment shall be large enough to allow easy routing and termination of fifteen 12 AWG [4 mm^2] conductors.

2-5.07. Controls Compartment. Each actuator shall be furnished with a sealed compartment containing a reversing controller, multi tap transformer, electronic controls, and monitoring and protection modules. Reversing controllers shall be both mechanically and electrically interlocked and provided with the necessary direct-operated auxiliary contacts for required interlocking and control. The multi tap

transformer shall provide power for all internal circuits, and shall provide 120 VAC supply for remote controls as indicated in the valve and gate schedules, or in the schematics on the Drawings.

Where not networked, actuators for valves or gates listed for modulating service in the valve and gate schedules shall be provided with a control module for position modulating type service. The control module shall be mounted within the controls compartment. The module shall accept a standard 4-20 mA dc analog input signal with a load impedance of not greater than 400 ohms. The control module shall contain adjustments for span, zero, gain, and deadband. Non-networked modulating actuators shall have a 4 to 20 mA output signal proportional to valve or gate position.

2-5.08. Local Controls. Each actuator shall have controller devices mounted on the actuator as indicated in the valve and gate schedules.

2-5.09. Remote Indication and Controls. Valve or gate position and actuator status indication for non-networked valves shall be provided by four configurable output relay contacts which can be selected to indicate any position of the valve or gate. Relays shall be configurable to the normally open or normally closed states. Relays shall maintain and update position indication during handwheel operation. Contacts shall be rated 5 A, 250 VAC, 30 VDC. When not used for position indication, any of the four configurable relays shall be selectable to signal one of the following:

Valve or gate opening, closing, or moving.
Thermostat tripped, phase loss.
Motor tripped on torque in mid travel, motor stalled.
Remote mode selected.
Local mode selected.

At a minimum, the actuator shall transmit the following status information through network:

Valve opening, closing, or moving.
Valve full open, full closed.
Thermostat tripped, phase loss.
Motor tripped on torque in mid travel, motor stalled.
Remote mode selected.
Local mode selected.
Valve position.
Valve torque.

2-6. STANDARD ELECTRIC ACTUATORS. Not Used.

2-7. HYDRAULIC CYLINDER ACTUATORS. Not used.

2-8. AIR CYLINDER ACTUATORS. Not used.

2-9. VANE TYPE PNEUMATIC ACTUATORS. Not used.

2-10. AIR-OIL CYLINDER ACTUATORS. Not used.

2-11. PORTABLE ELECTRIC ACTUATORS. Not used.

2-12. PORTABLE HYDRAULIC ACTUATORS. Not used.

2-13. ACTUATOR ACCESSORIES.

2-13.01. Extension Stems. Extension stems and stem guides shall be furnished when indicated in the respective valve schedules, indicated on the Drawings, or otherwise required for proper valve operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the actuator shaft. Extension stems shall be connected to the actuator with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.

At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet [3 m], whichever is smaller. The top stem guide shall be designed to carry the weight of the extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.

Extension stems for chemical resistant butterfly valves located in drainage sumps shall be the two-piece type with stainless steel stem, PVC housing, wall support, and collar. Unless otherwise indicated on the Drawings, the length of the stem extension shall be as necessary to position the valve operator 12 inches above the maximum liquid level in the immediate area.

Extension stems for buried valve actuators shall extend to within 6 inches [150 mm] of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.

Extension stems for buried valve actuators shall be provided with position indicators as specified in the valve schedules.

2-13.02. Position Indicators. Unless otherwise specified, each valve actuator shall be provided with a position indicator to display the position of the plug or disc relative to the body seat opening.

For quarter turn plug, ball, or cone type valves installed in interior locations, the indicating pointer shall be mounted on the outer end of the valve operating shaft

extension and shall operate over an indicating scale on the operating mechanism cover. Where the shaft passes through the cover, a suitable stuffing box or other seal shall be provided to prevent the entrance of water.

Each actuator for butterfly valves, except where located in manholes, buried, or submerged, shall have a valve disc position indicator mounted on the end of the valve shaft. A disc position indicator shall also be provided on each operating stand or the actuator mounted thereon.

2-13.02.01. Position Indicators for Buried Actuators. When specified in the respective valve schedules, each buried valve actuator shall be equipped with a position indicator. Position indicators shall be Indico "Model 179 Valve Position Indicators" manufactured by the Mills Engineering Company, Needham Heights, Massachusetts, or "Diviner" ground level position indicator manufactured by the Henry Pratt Company, Aurora, Illinois. Each indicator assembly shall be designed for installation on the extension stem connected to the operating stem of the buried actuator mechanism and shall be mounted in the top section of the valve box beneath the valve box cover. Each indicator shall be equipped with a wrench nut. Internal gearing shall be sealed and protected from the elements.

2-13.03. Floor Boxes. Openings through concrete slabs provided for key operation of valves shall be provided with a cast iron floor box complete with cover. The floor box shall be of the depth indicated on the Drawings. Where the operating nut is in the slab, the stem shall have a guide to maintain the nut in the center of the box; where the nut is below the slab, the opening in the bottom of the box shall accommodate the operating key.

Each floor box and cover shall be shop coated with manufacturer’s standard coating.

2-13.04. Torque Tubes. Torque tube shall utilize pipe rather than solid shafting between the valve input shaft and the output shaft of the valve floorstand operator. An adjustment of 2 inches [50 mm] shall be provided in the torque tube installation. Torque tube shall be coated with the same material as the submerged valve.

2-13.05. Valve Boxes. Each valve buried to a depth of 4 feet [1.2 m] or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches [125 mm] in inside diameter, shall be at least 3/16 inch [4.7 mm] thick, and shall be provided with suitable cast iron bases and covers.

Each valve buried deeper than 4 feet [1.2 m] shall be provided with a valve box consisting of a cast iron cover and a 6 inch [150 mm] Cast Iron Pipe section. The cover shall be Clay & Bailey "No. 2193". The pipe shaft shall extend from the valve to 5 inches [125 mm] inside the valve box cover.

All parts of valve boxes, bases, and covers shall be shop coated with manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2-14. SHOP PAINTING. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.

The following surfaces shall be painted:

Polished or Machined Surfaces	Rust-preventive compound.
Other Surfaces	Epoxy.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3-1. INSTALLATION. Actuators will be installed on the valves in accordance with the Valve Installation section and on gates in accordance with the Gate Installation section.

End of Section

Section 15250

MECHANICAL INSULATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of insulation, jackets, and accessories for the following mechanical systems:

- piping

Building insulation materials are specified in other sections. Insulation for mechanical equipment which is to be applied at the factory prior to shipment is specified in the individual equipment sections.

Electrical heat tracing for piping shall be as specified in the Electrical section.

1-2. GENERAL. Materials furnished and installed under this section shall be in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall be responsible for coordinating the installation of insulation with the installation of the items or systems to be insulated. Each item or system shall be tested and accepted by Engineer before installation of the insulation materials.

Contractor shall verify that each component of the insulation systems is compatible with all other parts of the system; that all insulation materials are appropriate for the intended applications; and that all necessary devices and accessories have been provided.

All insulation of the same class shall be the product of a single manufacturer; however, all the insulation types need not be the products of one manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal

codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL, NFPA, and ASTM safety requirements.

1-2.04. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.05. Surface Burning Characteristics. Insulation, jackets, tapes, and adhesives to be used indoors shall have a composite flame spread rating not to exceed 25 and a composite smoke developed rating of 50 when tested by UL 723, NFPA 255, or ASTM E84. All testing shall be done on materials of the same densities and installed thicknesses as the materials being installed. Insulation materials which have been treated with a flame retardant additive to meet the required flame spread and smoke developed ratings are not acceptable.

1-2.06. Painting and Identification. Field painting and identification shall be as specified in the Protective Coatings section.

Piping systems with electrical heat tracing shall have warning labels attach to the outside of the pipe thermal insulation weather barrier to indicate the presence of electric heat tracing. Labels shall be located every 10 feet 3 m of pipe, alternating on either side. The labels shall be black on yellow, weatherproof, mylar, with pressure sensitive adhesive and at least 2 inches 50 mm by 6 inches 150 mm minimum.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. A complete list of materials and catalog cuts, together with detailed specifications, materials performance data, installation instructions, parts, devices, and accessories furnished, shall be submitted in accordance with the Submittals Procedures section. Information shall include certified test results to show compliance with UL, NFPA, and ASTM safety requirements.

Product data for adhesives shall include VOC content.

1-4. QUALITY ASSURANCE.

1-4.01. Manufacturer Experience. A manufacturer shall have furnished material of the type specified which has been in successful operation for not less than the past 5 years.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-2. MATERIALS. Insulation, vapor retarders, and field applied jackets shall be installed to cover piping, ductwork, equipment, fittings, and appurtenances as indicated in the Insulation Schedule.

2-2.01. Pipe Insulation.

2-2.01.01. Type PMF1 Insulation. Type PMF1 mineral fiber pipe insulation shall be Johns Manville "Micro-Lok", Knauf "Pipe Insulation" or Owens-Corning.

Type PMF1 pipe insulation shall be a one-piece molded glass fiber material with all-purpose jacket. The all-purpose jacket shall be factory-applied, fiberglass reinforced vapor barrier type, with white kraft bonded to aluminum foil and self sealing adhesive lap. The insulation shall be suitable for a temperature range of 0°F to 850°F -18°C to 454°C, shall have a maximum thermal conductivity (k) of 0.24 Btu in/hr ft^2 °F at 75°F 0.035 W/m °C at 24°C, and shall conform to ASTM C547.

2-2.01.02. Type PMW1 Insulation. Not used.

2-2.01.03. Type PFC1 Insulation. Type PFC1 flexible cellular elastomeric pipe insulation shall be Armacell "AP/Armaflex" or K-Flex USA "Insul-Tube" for unslit insulation and Armacell “AP/Armaflex SS” or K-Flex USA “Insul-Lock Seam-Seal” for factory pre-slit insulation. Flexible cellular polyolefin foam insulation shall be IMCOA "Imcolock" or Plastic Technology, Inc. “Innofoam”.

Type PFC1 pipe insulation shall be one-piece, molded elastomeric or polyolefin foam insulation suitable for a temperature range of -40°F to 180°F -40°C to 82°C, and shall have a maximum thermal conductivity (k) of 0.28 Btu in/hr ft^2 °F at 75°F 0.040 W/m °C at 24°C. The insulation shall be suitable for exposure to weather and direct sunlight or, where not indicated to be jacketed, shall be given two coats of an ultraviolet-resistant finish recommended by the manufacturer. Insulation shall conform to ASTM C534 for elastomeric or ASTM C1427 for polyolefin.

2-2.02. Duct Insulation.

2-2.02.01. Type DMF1 Insulation. Type DMF1 semi-rigid type duct insulation shall be Johns Manville "800 Series Spin-Glas", Knauf "Insulation Board", or Owens-Corning “Fiberglas 705”.

Type DMF1 exterior insulation for rectangular ductwork shall be a semirigid, 6 pounds per cubic foot 96 kg/m^3 density fiberglass material with a factory-applied all service

jacket. Insulation suitable for temperatures of up to 150°F 66°C, and shall have a maximum thermal conductivity (k) of 0.23 Btu in/hr ft2 °F at 75°F 0.033 W/m °C at 24°C. The insulation shall conform to ASTM C612.

2-2.03. Equipment Insulation.

2-2.03.01. Type EMF1 Insulation. Not used.

2-3. ACCESSORIES.

2-3.01. PVC Insulation Jackets. Not used.

2-3.02. Aluminum Insulation Jackets. Aluminum insulation jackets for insulated piping systems shall be furnished and installed as indicated in the insulation schedule herein and where indicated on the Drawings. Aluminum jackets shall be manufactured from alclad conforming with ASTM B209. The aluminum jacket shall have a nominal thickness of 0.024 in. 0.61 mm0.032 in. 0.81 mm, with an embossed finish.

Fittings in insulated piping systems and equipment where indicated in the insulation schedule shall be provided with aluminum jackets of the same aluminum jacketing material as the piping systems. The jacket shall have a factory-applied moisture retarder of at least 3 mils 76 µm permanently bonded to the interior surface and extending the full width of the jacket. The retarder shall consist of Polysurlyn or polyethylene film and kraft paper.

PART 3 - EXECUTION

3-1. INSTALLATION.

3-1.01. General. Contractor shall install all insulation materials as specified herein for the piping systems, ductwork, and equipment that are not factory insulated. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried. All work shall be performed within the temperature ranges recommended by the insulation product manufacturer. Insulation shall be kept clean and dry and shall remain in the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label with the name of the manufacturer and description of materials.

Seams of exposed insulation and jackets shall be in the least visible location.

All adhesives used on the interior of the building defined as inside the weatherproofing system shall have a VOC content not greater than 80 g/L.

3-1.02. Piping Insulation.

3-1.02.01. Type PMF1 Insulation. Pipe insulation, vapor retarders, and field applied jackets shall be installed to cover system piping, fittings, and appurtenances. Insulation shall be full factory unit lengths using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. End joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.

Insulated piping conveying fluids at lower than ambient temperatures shall be jacketed with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and shall be sealed with vapor barrier coating. The vapor barrier coating shall be applied at intervals not exceeding 15 feet 4.6 m for straight runs and not more that 6 inches 150 mm from fittings. Fibrous insulation laps and butt strips that are not self-sealing shall be secured with adhesive and stapled. Staples and seams shall be coated with vapor barrier material.

On piping 2 inches 50 mm and larger where the insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be of the same thickness and contour as the adjacent insulation and installed to maintain a continuous vapor barrier through the support. The insert shall be constructed of wood or heavy density insulating material suitable for the system operating temperatures.

3-1.02.02. Type PMW1 Insulation. Not used.

3-1.02.03. Type PFC1 Insulation. Pipe insulation shall be installed to cover all pipe, fittings, and appurtenances with all seams and joints sealed by a factory or field applied adhesive. Insulation at fittings and appurtenances shall be carefully formed and fitted. Insulation at elbows shall be mitered using segments of pipe insulation.

3-1.03. Duct Insulation. Insulation for ducts indicated on the Drawings as wrapped shall be installed as specified herein and indicated on the Drawings. Duct insulation shall be continuous through hangers and penetrations, except firewall penetrations but shall be interrupted at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their functioning and/or replacement. Insulation jackets shall be continuous across seams, reinforcement, and projections.

Insulation on ducts conveying air at temperatures below 60°F 16°C shall be installed with a continuous vapor barrier seal. Staples and joints shall be sealed with a vapor barrier coating.

3-1.03.01. Type DMF1 Insulation. Type DMF1 semirigid insulation shall be secured to all four sides of the duct with mechanical fasteners, spaced not more than 12 inches 305 mm apart and not more than 3 inches 76 mm from the edges of the insulation

joints. At least two rows of fasteners shall be provided for each side of 12 inch 305 mm and larger ducts, and one row for each side of ducts smaller than 12 inches 305 mm. All joints in the insulation shall be sealed with 3 inch 76 mm wide joint sealing tape or 4 inch 102 mm wide strips of jacket material secured with adhesive and staples.

3-1.04. Equipment Insulation. Not used.

3-1.05. PVC Jacketing. Not used.

3-1.06. Aluminum Jacketing. Aluminum jacketing for piping systems shall be installed as specified herein and indicated on the Drawings. Jacketing shall be held in place with stainless steel securing bands uniformly spaced at not more than 18 inches 457 mm to produce tight joints without "bulging". The jacket shall overlap at least 2 inches 51 mm at longitudinal and circumferential joints. Joints shall be overlapped and sealed with caulk to prevent moisture penetration, and longitudinal joints shall be placed to shed water. Exposed ends of pipe insulation shall be provided with covers constructed of the same material as the jacketing.

Elbows shall be jacketed with spirally wrapped aluminum strips or individual mitered segments or gores cut to fit the insulation.

3-2. INSULATION SCHEDULE.

INSULATION SCHEDULE				
Service	Size Inches mm	Mechanical Insulation		Notes
		Type	Thickness Inches mm	
PIPING - INDOOR (CONCEALED OR EXPOSED)				
Condensate Drain	All	PMF1	1 25	(3)
Non-Potable Cold Water	Up to 3 80 4 100 & larger	PFC1 PFC1	3/4 20 1 25	(3) (3)
Potable Cold Water	Up to 3 80 4 100 & larger	PFC1 PFC1	3/4 20 1 25	(3) (3)

Potable Hot Water	Up to 1-1/4 32 1-1/2 40 & larger	PMF1 PMF1	1 25 1-1/2 40	(9) (9)
Refrigerant Suction and Hot Gas Bypass	Up to 1 25 1 25 & larger	PFC1 PFC1	1-1/2 40 1-1/2 40	
PIPING - OUTDOOR (EXPOSED)				
Refrigerant Suction and Hot Gas Bypass	Up to 1 25 1 25 & larger	PFC1 PFC1	1-1/2 40 1-1/2 40	(1)
Piping with Heat Tracing	All	PMF1	1-1/2 40	(1)
Mechanical Insulation Types:	FC - Flexible Cellular MF - Mineral Fiber MW - Mineral Wool			

Notes:

(1) Aluminum jacket.

(2) PVC jackets shall be provided on exposed portions of insulated piping located less than 8 feet 2.4 m above finished floor. On all other portions of the insulated piping system PVC jackets shall be provided only for fittings.

(3) Insulation shall be provided for portions of the piping system which pass through space above finished ceilings or is exposed above equipment, electrical panels, or cabinets.

(4) Insulation shall be provided for exposed portions of the piping system located less than 8 feet 2.4 m above the finished floor or grade.

(5) Insulation shall be provided for outside air plenums and ducts that are located upstream of the heating coil or pass through unheated spaces after the heating coil, unless indicated to be internally lined.

(6) Insulation shall be provided for outside air plenums and ducts, air conditioning supply and return ducts, and dehumidifier reactivation air discharge ducts, unless indicated to be internally lined.

(7) Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F 66°C.

(8) The underside of all roof drains shall be insulated to a 1 foot 300 mm radius from the center of the drain. All roof drain piping within 4 feet 1.2 m of the drain shall be insulated.

(9) Includes 8 feet 2.4 m of the cold water inlet piping to the water heater storage tank.

Unless otherwise indicated in the insulation schedule, all mechanical piping, ductwork, equipment, and accessories with an operating temperature in excess of 140°F 60°C and below 60°F 15°C shall be insulated.

End of Section

SECTION 15300

WET-PIPE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of dry standpipe sprinkler system in accordance with NFPA 13. The work described in this Section includes mechanical work only, all electrical connections shall be furnished under Division 16. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the Contractor's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:
   1. Section 02665, Water Mains and Accessories.
   2. Section 15050, Basic Mechanical Materials and Methods.
   3. Section 15060, Miscellaneous Piping and Pipe Accessories.
   4. Section 15100, Valves.
   5. Section 16723, Fire Protection and Signaling System

D. Sprinkler System Protection Limits: Automatic sprinkler system required for the Primary Headhouse Structure.

E. Sprinkler cabinet with spare sprinklers and sprinkler wrenches.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

   1. Product data for fire protection system components including but not limited to the following:

a. Back flow prevention assembly, alarm check valve, system valves, tamper switches, flow switch, accessories and devices.
b. Fire department connection. Include type of connection, size type, and arrangement of inlets, size and direction of outlet and finish.
c. Sprinklers, including flow characteristics, mounting, finish and other data.

2. Sprinkler system drawings identified as "working plans," prepared according to NFPA 13. Submit required number of sets to authority having jurisdiction for review, comment, and approval. Include system hydraulic calculations where applicable.
3. Test reports and certificates as described in NFPA 13. Include "Contractor's Material & Test Certificate for Aboveground Piping" and "Contractor's Material & Test Certificate for Underground Piping" as applicable to material provided under this Section.
4. Maintenance data for each type of fire protection specialty specified, for inclusion in "Operating and Maintenance Manual".
5. NFPA 13A "Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems."

1.03 DEFINITIONS

A. Pipe sizes used in this Section are nominal pipe size (NPS) specified in inches. Tube sizes are standard tube size specified in inches.

B. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.

C. Other definitions for fire protection systems are included in referenced NFPA standards.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.

B. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.

C. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in "National Electrical

Code," Article 100.

D. Comply with requirements of authority having jurisdiction for submittals, approvals, materials, hose threads, installation, inspections, and testing.

E. Installer's Qualifications: Firms qualified to install and alter fire protection piping, equipment, specialties, accessories, and repair and service equipment. A qualified firm is one that is experienced with a minimum of 5 previous projects similar in size and scope to this Project in such work, familiar with precautions required, and in compliance with the requirements of the authority having jurisdiction. Submit evidence of qualifications to the Engineer upon request.

F. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NFPA, National Fire Protection Association.
2. NEC, National Electrical Code.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ASTM, American Society for Testing Materials.
6. ASME, American Society of Mechanical Engineers.
7. AWWA, American Water Works Association.
8. FM, Factory Mutual Engineering Corporation.
9. UL, Underwriters Laboratories, Inc.

1.05 QUALITY STANDARDS

A. The standpipe and sprinkler system shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been designed in accordance with these specifications and is a suitable application for these service conditions. A certificate of unit responsibility shall be provided. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for this portion of the work.

C. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the standpipe and sprinkler system manufacturer shall not be accepted.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the contract Documents.

PART 2 - PRODUCTS

2.01 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and obtain approval from authority having jurisdiction for fire protection systems specified.

B. Verify City furnished supply main flow tests, as required, to obtain hydraulic data needed to prepare design for hydraulically calculated systems.

C. Hydraulically design sprinkler systems according to:

1. Sprinkler System Occupancy Hazard Classifications shall be Ordinary Hazard, Group 2.
2. Density Requirements for Automatic Sprinkler System Hydraulic Design shall be in accordance with NFPA 13, As follows:
   a. Ordinary Hazard, Group 2 Occupancy: 0.2 GPM over 1,500 sq. ft. area.
   b. Not used.
3. Maximum Sprinkler Spacing:
   a. According to NFPA 13.

D. Components and Installation: Capable of producing piping systems with the following minimum working pressure ratings except where otherwise required.

1. Sprinkler Systems: 175 psig
2. Standpipe and Hose Systems: 175 psig

E. All the electrical components of the fire protection systems such as flow switches, tamper switches, etc., shall meet the electrical area classification of the space they are located in.

2.02 PIPES AND TUBES

A. Steel Pipe: ASTM A53, Schedule 40 in sizes 6 inches and smaller and Schedule 30 in sizes 8 inches and larger, black and galvanized, plain and threaded ends, for welded, threaded, cut-groove and rolled-groove joints.

B. Ductile-Iron Pipe: AWWA C115, ductile-iron barrel with iron-alloy threaded flanges, 250 psig minimum working pressure rating, and AWWA C104 cement-mortar lining.

1. Option: Pipe may be AWWA pattern, cut-grooved for grooved-coupling joints.

2.03 PIPE AND TUBE FITTINGS

A. Steel Fittings: ASTM A234/ A234M, seamless or welded; SAME B16.9, butt welding; or ASME B16.11, socket-welding type for welded joints.

B. Grooved-End Fittings for Ductile-Iron Pipe: ASTM A 536 ductile-iron or ASTM A 47 malleable-iron, AWWA pipe-size, designed to accept AWWA C606 grooved couplings. Include cement lining or Food and Drug Administration (FDA)-approved interior coating.

C. Ductile-Iron and Gray-Iron Flanged Fittings: AWWA C110, 250-psig minimum pressure rating, with AWWA C104 cement-mortar lining.

2.04 JOINING MATERIALS

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for joining materials not included in this Section as required.

B. Flanged Joints for Ductile-Iron Pipe and Ductile-Iron or Cast-Iron Fittings: AWWA C115 ductile-iron or gray-iron pipe flanges, rubber gaskets, and high-strength steel bolts and nuts.

C. Couplings for Grooved-End Ductile-Iron Pipe and Fittings: UL 213, AWWA C606, ASTM A 536 ductile-iron housing, with enamel finish. Include synthetic-rubber gasket with central-cavity, pressure-responsive design, and ASTM A 183 carbon-steel bolts and nuts to secure grooved pipe and fittings.

2.05 DOUBLE CHECK DETECTOR BACKFLOW PREVENTER ASSEMBLY

A. Double check detector backflow preventer (BFP) assembly shall be provided in sizes to match that of the required fire line service piping.

B. The BFP assembly shall be provided with OS&Y gate valves on the inlet and outlet sides of the assembly.

C. The BFP assembly shall be provided with three brass ball valve test cocks fitted with brass or plastic threaded plugs. A fourth test cock shall be provided on the upstream side of the inlet shut off valve.

D. The BFP assembly and shut off valve bodies shall be cast iron, coated inside and outside with an NSF approved, fused epoxy coating and assembled with bolts that are resistant to electrolysis. All BFP assembly interior and exterior components shall be of materials equal in corrosion resistance to bronze and/or stainless steel to resist electrolysis.

E. Check valves shall have replaceable seats and shall be accessible by top entry only for maintenance and repair. The detector bypass line on the BFP assembly shall be ¾-inch copper and have a bronze detector meter and a ¾-inch double check valve assembly complete with unions and shut off valves.

F. The BFP assembly shall be classified or listed by the Underwriters Laboratories, Factory Mutual Insurance and bear the ASSE seal (ASSE Standard 1049). The BFP assembly shall also have the approval of and conform to all requirements of the University of Southern California, Foundation for Cross Connection Control (USC-FCCC). The BFP assembly shall be individually factory tested, shipped and installed as a unit.

G. The BFP assembly shall be tested at the time of installation. A copy of all test reports shall be submitted to the Engineer.

H. Acceptable Manufacturers: Zurn, Watts, Ames

2.06 GENERAL-DUTY VALVES

A. Refer to Section 15100 Valves for general-duty gate, ball, butterfly, globe, and check valves.

2.07 FIRE PROTECTION SERVICE VALVES

A. General: UL-listed and FM-approved, with 175 psig non-shock minimum working pressure rating.

1. Option: Valves for use with grooved piping may be grooved type.

B. Gate Valves, 2 Inches and Smaller: UL 262, cast-bronze, threaded ends, solid wedge, outside screw and yoke, rising stem.

C. Indicating Valves, 2-1/2 Inches and Smaller: Butterfly or ball type, bronze body with threaded ends, and integral indicating device.

1. Indicator: Electrical 115 volts a.c., prewired, single-circuit, supervisory switch.

D. Gate Valves, 2-1/2 Inches and Larger: UL 262, iron body, bronze mounted, taper wedge, outside screw and yoke, rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.

E. Gate Valves, 2-1/2 Inches and Larger for Use with Indicator Posts: UL 262, iron body, bronze mounted, solid wedge disc, non-rising stem with operating nut and flanged ends.

F. Indicator Posts: UL 789, wall type, cast-iron body, with windows for target plates that indicate valve position, extension rod and coupling, locking device, and red enamel finish.

1. Operation: Hand wheel.

G. Swing Check Valves, 2-1/2 Inches and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze disc ring and flanged ends.

H. Butterfly Check Valves, 4 Inches and Larger: UL 213, split-clapper style, cast-iron body with rubber seal, bronze alloy discs, stainless-steel spring and hinge pin.

2.08 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check valve with divided seat ring, rubber faced clapper to automatically actuate, with pressure retard chamber and variable pressure trim with test and drain valve.

B. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

C. Fire Department Connections:
1. Type: Free standing type with ductile iron pedestal red enamel finish.
2. Outlets: Two-way with fire department thread size. Threaded dust-cap and chain of matching material and finish.
3. Drain: 3/4 inch automatic drip, outside.
4. Label: "Sprinkler - Fire Department Connection"

2.09 SPRINKLERS

A. Automatic Sprinklers: With heat-responsive element conforming to UL 199.

B. Sprinkler types and categories shall be provided for the indicated service and as required by application. Furnish automatic sprinklers with nominal 1/2-inch (12.7 mm) orifice for "Ordinary" temperature classification rating except where otherwise indicated and required by application.

C. Acceptable Manufacturers: Grinnell Corp, Reliable Sprinkler Corp.

D. Special Coatings: Corrosion-resistant PTFE finish paint.

E. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

F. Sprinkler Cabinets: Finished steel cabinet and hinged cover, with space for minimum of 6 spare sprinklers plus sprinkler wrench, suitable for wall mounting. Include separate cabinet with sprinklers and wrench for each style sprinkler on Project.

2.10 PRESSURE GAGES

A. Pressure Gages: UL 393, 3-1/2 to 4-1/2 inches diameter dial with dial range of 0-250 psig.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine area for sprinkler system installation. Verify that sprinkler system piping may be installed in accordance with all pertinent codes and regulations.

3.02 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Refer to Part 2 of this Section for detailed specifications on pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping may be joined with flanges instead of indicated joints. Use grooved-end fittings with grooved couplings that are made by the same manufacturer and that comply with listing when used together for grooved-coupling joints.

3.03 JOINT CONSTRUCTION

A. Piping joint construction shall be in accordance with NFPA 13.

3.04 WATER SUPPLY CONNECTION

A. Fire protection piping shall be connected to water supply piping of size and in location where shown on Drawings.

B. Install shutoff valve, pressure gage, drain, and other accessories as required on connection to water supply piping.

C. Backflow preventer shall be installed on water supply piping ahead of fire protection piping connection.

3.05 PIPING INSTALLATIONS

A. Refer to Section 15050 Basic Mechanical Materials and Methods for basic piping installation.

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping.

1. Deviations from approved "working plans" for sprinkler piping require written approval from authority with jurisdiction.
2. Not used.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes 2 inches and smaller. Unions are not required on flanged devices or in piping installations using grooved couplings.

E. Install flanges or flange adapters on valves, apparatus, and equipment having 2-1/2-inch and larger connections.

F. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install drain valves on standpipe systems, of sizes and in locations as required.

I. Install ball drip valves to drain piping between fire department connections and check valves, and where required. Drain to floor drain or outside building.

J. Install alarm devices in piping systems.

K. Hangers and Supports: Comply with NFPA 13. Install according to NFPA 13 and NFPA 14.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than 1/4 inch and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit

removal, and install where they will not be subject to freezing.

3.06 VALVE INSTALLATIONS

A. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13 and NFPA 14, manufacturer's written instructions, and the authority having jurisdiction.

B. Gate Valves: Install fire-protection service valves supervised-open, located to control sources of water supply except from fire department connections. Where there is more than one control valve, provide permanently marked identification signs indicating portion of system controlled by each valve.

3.07 SPRINKLER APPLICATIONS

A. Sprinkler Type: Upright, pendent type.

B. Sprinkler Finishes: Use sprinklers with following finishes:

1. Upright, Pendent Sprinklers: Rough bronze, PTFE-coated.

3.08 SPRINKLER INSTALLATIONS

A. Install sprinklers in patterns as required to achieve compliance with NFPA 13.

3.09 FIRE DEPARTMENT CONNECTION INSTALLATIONS

A. Install fire department connections of types and features indicated in locations indicated.

B. Install ball drip valves at each check valve for fire department connection to mains and where required. Drain to floor drain or outside building.

3.10 CONNECTIONS

A. Connect to specialty valves, specialties, fire department connections, and accessories.

B. Connect water supplies to standpipe and sprinkler systems.

C. Electrical Connections: Power wiring is specified and provided under Division 16.

D. Connection of alarm devices to fire alarm system shall be furnished under Section 16723.

3.11 FIELD QUALITY CONTROL

A. Perform field acceptance tests of each fire protection system. Replace any components required to demonstrate successful operation and compliance.

1. Flush, test, and inspect sprinkler piping systems according to NFPA 13 Chapter "System Acceptance."
2. Flush, test, and inspect standpipe systems according to NFPA 14 Chapter "Tests and Inspection."

3.12 CLEANING

A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.13 COMMISSIONING

A. Starting Procedures: Follow manufacturer's written procedures. Including the following:

1. Verify that specialty valves, trim, fittings, controls, and accessories have been installed correctly and operate correctly.
2. Verify that specified tests of piping are complete.
3. Check that damaged sprinklers and sprinklers with paint or coating not specified have been replaced with new, correct type of sprinklers.
4. Check that sprinklers are correct type, have correct finish and temperature ratings, and have guards where required for applications.
5. Check that potable water supplies have correct type of backflow preventer.
6. Check that fire department connections have threads compatible with local fire department equipment and have correct pressure rating.

B. Coordinate with fire alarm system tests. Operate systems as required.

3.14 DEMONSTRATION

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with at least 7 days' advance notice.

End of Section

Section 15400

PLUMBING

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of materials, appliances, fixtures, equipment, and appurtenances associated with the plumbing systems as specified herein and as indicated on the Drawings. Additional requirements for plumbing systems shall be as indicated in the schedules on the Drawings. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

Pipe materials, valves, thermal insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1-2. GENERAL. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of industrial grade water heaters, and support equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall conform to the requirements of AGA, ASTM, NFPA, and UL safety requirements.

1-2.05. Power Supply. Unless otherwise specified, power supply to equipment with motors shall be as indicated on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1-2.06. Metal Thickness. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Equipment, Piping Accessories, and Appurtenances

- Name of manufacturer.
- Type and model.
- Construction materials, thicknesses, and finishes.
- Capacities.
- Pressure and temperature ratings.
- Overall dimensions.
- Piping connection sizes and locations.
- Net weight.
- Horsepower [kW].
- Power requirements.

Wiring diagrams.

Plumbing Fixtures

Name of manufacturer.
Type and model.
Construction materials, thicknesses, and finishes.
Water consumption data.
Overall dimensions.
Rough-in dimensions.
Piping connection sizes and locations.
Net weight.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operations and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

Operation and maintenance manuals are required for emergency fixtures, and water heaters.

1-4. QUALITY ASSURANCE.

1-4.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1-4.02. Qualification. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

1-4.03. Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1-4.04. Construction. Plumbing fixtures shall be constructed in accordance with the following standards:

Enameled Cast Iron	ANSI/ASME A112.19.1M
Vitreous China	ANSI/ASME A112.19.2M
Stainless Steel	ANSI/ASME A112.19.3M

Faucets	ANSI/NSF 61
Emergency/Safety Fixtures	ANSI Z358.1

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for each type and size of plumbing fixture or equipment as required, in the quantities indicated below.

Part	Number Required
Faucet washer cartridge and O-ring kits	1 per 5 fixtures
Electric water heater elements	1 per heater
Water heater relief valves	1 per heater

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All plumbing fixtures and equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the Drawings.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the contract Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MANUFACTURE AND FABRICATION.

2-4.01. Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage In Concrete and Masonry section unless otherwise indicated on the Drawings.

2-4.02. Surface Preparation. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2-4.03. Shop Painting. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the Protective Coatings section.

2-4.04. Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches [150 mm] high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2-4.05. Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2-4.06. Piping Systems. Unless otherwise specified herein, piping system materials shall be as specified in other sections.

2-4.07. Valves. Unless otherwise specified herein, valves indicated to be a part of the plumbing systems shall be as specified in other sections.

2-5. WATER SUPPLY PIPING ACCESSORIES.

2-5.01. Water Hammer Arresters. Water hammer arresters shall be either bellows or piston type. Bellows type arresters shall consist of a stainless steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arresters shall consist of a seamless Type L copper shell, a seamlessly spun and factory charged air chamber, a factory lubricated double or triple O-ring sealed piston, and a threaded copper adapter. Water hammer arresters shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1010. Arresters shall be rated for a maximum working pressure of 350 psig [2400 kPa gauge] and a temperature range of 33°F to 250°F [1°C to 120°C]. Water hammer arresters shall be Smith "Hydrotrol", Josam "75000 Series Absorbotron", Wade "Shokstop", or Sioux Chief "Hydra-Rester".

2-5.02. Trap Primers. Not used.

2-5.03. Thermostatic Mixing Valves. Not used.

2-5.04. Vacuum Relief Valves. Vacuum relief valves shall have bronze or brass bodies rated for 200 psig and shall be provided with male threaded inlet connections. The valves shall open at 1/2 inch water column vacuum and shall have a venting capacity of at least 15 cubic feet per minute. Vacuum relief valves shall be Watts Regulator "Model LFN36", Cash Acme “VR-801”, or Apollo Valves “Model VR”.

2-5.05. Thermometers. Thermometers shall be Weksler Instruments "Adjust Angle", Ashcroft "Series EI Everyangle" or Weiss Instruments, Inc. “Vari-angle”.

Thermometers shall be bimetal type and shall have a dial at least 4-1/2 inch [114 mm] diameter, with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

Each indicator shall be furnished with an angularly adjustable frame for convenient viewing. Unless otherwise indicated, thermometer range shall be 0 to 200°F [-10 to 110°C].

Each thermometer shall be furnished with a stainless steel thermowell for installation in the piping systems. The thermowells shall have 3/4 inch [20 mm] NPT thread mounts, a minimum pressure rating of 250 psig [1725 kPa gauge], and a nominal 4 inch [100 mm] insertion length.

2-5.06. Strainers. Strainers shall be provided where indicated on the Drawings. Strainer screen size shall be 20 mesh unless otherwise indicated. The blowoff from each strainer shall be equipped with a shutoff valve.

Strainers located in copper piping systems shall be Y-pattern type with bronze body, threaded ends, and monel or stainless steel screens. Strainers shall be Watts “Series LF777SI”, Apollo Valves “Model YB-LF” or Wilkins “Model YBXL”.

Strainers located in ductile iron piping systems shall be Y-pattern type with iron body, flanged ends, and monel or stainless steel screens. Strainers shall be Hoffman Specialty “Series 400” or Metraflex “Model TF”.

2-5.07. Hose Faucets. Hose faucets shall be constructed with nickel or chrome plated cast brass body, solid brass stem, threaded bonnet, and “T” style handle. Hose faucets shall be provided with a 3/4 inch male pipe thread inlet and a 3/4 inch male hose thread outlet unless otherwise indicated on the Drawings. Hose faucets shall be Prier Brass “Model C-138NP.75”, Arrowhead Brass Products, or Zurn.

Where indicated on the Drawings, hose faucets shall be equipped with hose connection vacuum breakers. Hose connection vacuum breakers shall be provided with 3/4 inch [19 mm] hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be equipped with manual drain. Hose connection vacuum breakers shall be Febco “Series 731”, Watts Regulator Company “Series 8” or Wilkins “Model BFP 8”.

2-5.08. Hose Valves. Not used.

2-5.09. Wall Hydrants. Not used.

2-5.10. Pressure Gauges. Pressure gauges shall be Ashcroft "Duragauge 1279", Weksler, or Weiss Instruments, Inc.

Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade A or better. Gauges shall be indicating dial type with C-type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.
The dial shall be 4-1/2 inch [114 mm] in diameter with black markings on a white background. The units of measurement shall be psi and shall be indicated on the dial face. The pointer shall span not less than 200 degrees nor more than 270 degrees. The range shall be selected so that the normal operating reading is near the midpoint of the scale.

Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Ball Valves section.

All stem-mounted gauges shall be provided with 1/2 inch [13 mm] NPT connections.

2-6. DRAINAGE AND VENT PIPING ACCESSORIES.

2-6.01. Cleanouts. Cleanouts shall be provided where indicated on the Drawings and required by the referenced codes, and shall be of the required type.

Floor cleanouts shall consist of a two piece body, a threaded plug, an adjustable head, and a cover. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanout covers shall be stainless steel. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T-pattern, 90 degree drainage fitting.

Cast iron cleanouts shall be manufactured by Smith, Josam, or Wade.

2-6.02. Bell-Up Drains. Not used.

2-6.03. Funnel Receptors. Funnel receptors shall consist of cast iron funnels with cast iron dome type bottom strainers. Funnel receptors shall be provided with waterstop flange and threaded or no-hub outlet connections suitable for connection to the waste piping. Funnel receptors connected to chemical resistant waste systems shall be furnished with a factory applied chemical resistant interior coating. Unless otherwise indicated, funnel receptors shall be installed 1 inch [25 mm] above the finished floor.

Funnel receptors shall be Smith “Series 3800 Figure SQ-3-1793-DBS”, Josam, or Wade.

2-6.04. Floor Drains. Floor drains shall be of the types specified herein and indicated on the Drawings. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the Drawings. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.

Cast iron floor drains shall be manufactured by Smith, Josam, or Wade.

2-6.05. Roof Drains and Overflow Roof Drains. Not used.

2-6.06. Downspout Nozzles. Not used.

2-6.07. Modular Trench Drain System. Not used.

2-6.08. Floor Sinks. Not used.

2-6.09. Backwater Valves. Not used.

2-6.10. Vent Flashings. Plumbing vent flashings shall be furnished and installed as indicated on the Drawings.

2-7. PLUMBING FIXTURES AND ACCESSORIES.

2-7.01. General. Plumbing fixtures shall be provided with all required supports, fasteners, supply and drain fittings, gaskets, and escutcheons required for a complete installation.

2-7.02. Water Closets. Not used.

2-7.03. Urinals. Not used.

2-7.04. Lavatories. Not used.

2-7.05. Showers. Not used.

2-7.06. Stainless Steel Sinks. Not used.

2-7.07. Janitors Sinks. Not used.

2-7.08. Emergency Fixtures. Emergency fixtures, including showers, eye/face washes, and combination shower/eye/face wash units shall be furnished and installed as indicated on the Drawings. Emergency fixtures shall be manufactured by Haws, Guardian, or Encon.

2-7.08.01. Indoor Emergency Eyewash Fixtures. Not used.

2-7.08.02. Indoor Emergency Shower Fixtures. Not used.

2-7.08.03. Indoor Combination Units. Not used.

2-7.08.04. Corrosion Resistant Combination Units. Corrosion resistant combination emergency shower/eye/face wash fixtures shall be pedestal mounted, with 2-1/2 inch schedule 80 PVC stanchion, floor flange, deluge shower, aerated eye/face wash, eye/face wash dust cover, stay-open stainless steel ball valves, interconnecting piping, and universal emergency sign. The shower shall be stainless steel or ABS plastic with stainless steel pull rod actuator. The eye/face wash receptor shall be stainless steel or plastic with push plate actuator.

2-7.08.05. Freezeproof Emergency Eyewash Fixtures. Not used.

2-7.08.06. Freezeproof Emergency Shower Fixtures. Not used.

2-7.08.07. Freezeproof Combination Units. Not used.

2-7.08.08. Alarm Systems. An audible and visual alarm system shall be provided when indicated on the Drawings. The alarm system shall activate based on water flow when either the emergency shower or eyewash fixture is operated. The alarm system shall provide local and remote alarm indication as indicated on the Drawings. The water flow switch shall be provided with double-pole double-throw contacts rated 5 amperes at 125 volts, suitable for remote alarm annunciation. The audible alarm shall provide an intermittent signal rated at 90 dB at 10 feet. The alarm light shall be amber, flashing type. The alarm system shall be pre-wired and shall be furnished with all necessary junction boxes, conduit, wire, and accessories for a complete installation. The alarm system shall be suitable for a 120 volt power supply.

2-7.08.09. Tempered Water Blending Valves. Tempered water blending valves shall be designed specifically for providing tempered water to emergency shower and eyewash fixtures. Each valve shall contain thermostatic elements, integral cold water bypass, and positive hot water shutoff to prevent scalding. Blending valves shall have bronze or brass bodies with threaded inlet and outlet connections and shall be provided with isolation check valves on the hot and cold supplies to the unit. Each unit shall include hot, cold, and blended water temperature gauges and shall be factory set for a blended water temperature of 70°F.

Tempered water blending valves serving eyewash fixtures, a single shower, or a single combination unit shall be suitable for a flow range of 3 to 25 gallons per minute [0.2 L/s to 1.9 L/s] and shall be Haws “Model 9201”, Guardian”G3700”, or Lawler “Model 911E. Tempered water blending valves serving multiple showers or multiple combination units shall be suitable for a flow range of 3 to 60 gallons per minute [0.2 L/s to 4.5 L/s] and shall be Haws “Model 9202”, Guardian “G3900” or Lawler “Model 911”.

2-7.08.10. Electric Instantaneous Emergency Fixture Water Heaters. Not used.

2-7.09. Wash Fountains. Not used.

2-7.10. Electric Water Coolers. Not used.

2-7.11. Food Waste Disposers. Not used.

2-8. PLUMBING EQUIPMENT.

2-8.01. General. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

2-8.02. Water Heaters and Accessories. Water heaters shall be furnished and installed where indicated on the Drawings. Heater type, storage capacity, recovery rate, energy input, power supply requirements, manufacturer, and model shall be as indicated on the Drawings.

2-8.02.01. Commercial Grade Electric Storage Water Heaters. Not used.

2-8.02.02. Industrial Grade Electric Storage Water Heaters. Electric storage water heaters shall be industrial type, with a nickel-lined tank and one or more heating elements. Heaters shall be provided with a cold water inlet tube, high density fiberglass insulation, a drain valve, and adjustable thermostats. Heating elements shall be immersion type, incoloy sheathed, low or medium watt density, and shall be field replaceable. Heater tank shall be ASME stamped for a working pressure of at least 125 psig [862 kPa gauge]. The heater tanks shall be provided with an inspection port at least 12 inches [300 mm] in diameter. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heater shall be UL and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. The water heaters shall be manufactured by PVI Industries Inc.

2-8.02.03. Electric Instantaneous Water Heaters. Not used.

2-8.02.04. Commercial Grade Gas-Fired Water Heaters. Not used.

2-8.02.05. Industrial Grade Gas-Fired Water Heaters. Not used.

2-8.02.06. Water Heater Flues. Not used.

2-8.03. Neutralization Tanks. Not used.

2-8.04. Hose Reels. Not used.

2-8.05. Hoses. Hose type, diameter, manufacturer, and model shall be as indicated on the Drawings.

Unless otherwise indicated, each hose shall be provided with one male swivel type brass hose connector, one female brass hose connector, and one regulating wash-up spray nozzle. Spray nozzles in 1 inch [25 mm] and 1-1/2 inch [38 mm] sizes shall be Potter-Roemer Inc. "Series 2970" with a cast brass body, a rubber bumper, and a female hose thread.

2-8.05.01. Type 1 Hoses. Not used.

2-8.05.02. Type 2 Hoses. Type 2 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig [1030 kPa gauge] working pressure. The hose shall consist of 3/4 inch [19 mm] ID heavy-duty ethylene, propylene diene (EPDM)

rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 2 hoses shall be Gates Rubber Company "Adapta Flex" or Potter-Roemer “Model 2851”.

2-8.05.03. Type 3 Hoses. Not used.

2-8.05.04. Type 4 Hoses. Not used.

2-8.06. Interceptors. Not used.

2-8.07. Expansion Tanks. Not used.

2-8.08. Water Storage Tank. Not used.

2-8.09. Automatic Water Softener Unit. Not used.

2-9. COLOR. Vitreous china, cast iron, enameled steel, and composite plumbing fixtures shall be white unless otherwise indicated. Other plumbing fixtures shall be the manufacturers standard color. Plumbing equipment shall have the manufacturer's standard color and finish unless otherwise indicated in the schedules.

2-10. ELECTRICAL. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3-2. PREPARATION.

3-2.01. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

3-3. INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Unless otherwise indicated, sleeves shall be provided for all pipe penetrations through concrete and masonry walls. Sleeves and sealing requirements shall be as indicated in the Miscellaneous Piping and Accessories Installation section and as indicated on the Drawings.

Not all required reducing fittings and unions are indicated. Additional fittings and unions shall be provided as needed to connect all equipment and appurtenances.

Insulating fittings shall be provided to prevent the contact of dissimilar metals in piping systems.

When located indoors, fuel gas pressure regulator vents and fuel train vent valves shall be piped to the exterior of the building in accordance with the applicable codes and standards.

Piping shall not be routed over or in front of electrical switchboards or panels unless acceptable to Engineer.

3-3.01. Water Supply Piping and Accessories. Water hammer arresters shall be provided in the hot and cold water supply piping at all quick closing valves, at solenoid valves, and at plumbing fixtures. When not indicated on the Drawings, arresters shall be located and sized by Contractor in accordance with PDI Standard No. WH201. Contractor shall submit arrester location and sizing plans to Engineer for approval prior to installation. Where possible, water hammer arresters shall be installed in an accessible location.

Water supply piping to hose faucets and hose valves shall be secured with a pipe support within 6 inches [150 mm] of the fixture.

3-3.02. Drainage and Vent Piping and Accessories. Unless otherwise indicated or required by code, horizontal sanitary drainage piping 3 inches [75 mm] in diameter or smaller shall be installed at a uniform slope of 1/4 inch per foot [2 percent]; horizontal sanitary drainage piping larger than 3 inches [75 mm] in diameter shall be installed at a uniform slope of 1/8 inch per foot [3 mm/300 mm]; horizontal storm drainage piping shall be installed at a uniform slope of 1/8 inch per foot [3 mm/300 mm].

Drainage fittings shall be installed to convey flow in the piping in the intended direction. To the extent possible, changes in direction shall be made by sweep type fittings. Quarter-bends and sanitary tee fittings shall not be installed for vertical to horizontal or horizontal to horizontal changes of direction.

Plumbing vents through roofs shall be located at least 12 inches [300 mm] from a parapet or from the intersection of a cant with the roof deck, and shall be installed with watertight flashings. Plumbing vents shall be located no closer to operable windows or air intakes than is allowed by the applicable code.

Vents connecting to horizontal sanitary piping shall connect above the centerline of the piping and shall rise at an angle of not less than 45 degrees from the horizontal to a point at least 6 inches [150 mm] above the flood level rim of the fixture served before offsetting horizontally.

Floor drains shall be adjusted to the correct elevation for proper drainage. Heads of fastening screws shall be flush with the grate surface.

Cleanouts on drainage piping inside structures shall be located where indicated on the Drawings. Additional cleanouts shall be provided where required by the applicable code or authority having jurisdiction. Cleanouts located in drainage risers shall be located 12 inches [300 mm] above the finished floor.

Unless otherwise indicated or required by the applicable code, cleanout size shall equal the line size for 4 inch [100 mm] and smaller drainage piping, and 4 inches [100 mm] in diameter for drains larger than 4 inch [100 mm]. Proper clearance shall be provided for access to cleanouts. Floor cleanouts shall be installed flush with the finished floor.

Floor drains, trench drains, floor sinks, funnel receptors, and bell-up drains indicated to be equipped with traps shall be provided with deep seal "P" traps located as close to the drain as possible.

3-3.03. Plumbing Fixtures and Accessories. Plumbing fixtures shall be set level and plumb, and shall be securely attached to the floor or wall. Unless otherwise indicated on the Drawings, each fixture shall be mounted at the height recommended by the manufacturer.

Fixture traps shall be easily removable for servicing and cleaning. Escutcheons shall be placed at all locations where fixture supply or drain piping penetrates walls, floors, or ceilings.

Water piping at stop valves, and shower heads shall be rigidly secured to blocking. Drop-ear elbows shall be used whenever possible. All water supply piping shall be cleaned and flushed before the plumbing fixtures are installed.

Shutoff valves located in the tempered water (TW) supply piping to safety fixtures and shutoff valves in the potable water branch piping to the TW system shall be provided with tags bearing the legend ”WARNING: DO NOT CLOSE VALVE WITHOUT AUTHORIZATION". The tags shall have an orange background and black lettering not

less than 1/2 inch in height. Other features of the tags shall be as indicated in the Mechanical Identification paragraph.

3-3.04. Plumbing Equipment. Plumbing equipment shall be installed in accordance with the manufacturer's recommendations. Adequate clearance shall be provided for access to all components which may require adjustment, servicing, or replacement.

Water heaters shall be installed in accordance with AGA, NSF, NFPA, and UL requirements. Storage type water heaters shall be cleaned and flushed before being connected to the potable water system. Water heater relief valves shall be piped to the nearest drain or as indicated on the Drawings, and shall terminate the appropriate air gap distance above the drain. Unless otherwise indicated, water heater thermostats shall be set such that the maximum water temperature does not exceed 140 ^{o}F [60 ^{o}C].

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer for industrial grade water heaters shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-4.02. Startup and Testing. Field performance tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3-5. ADJUSTING. All devices shall be adjusted for proper flow and quiet operation. Faucet and supply assemblies shall be adjusted or repaired to eliminate leaks. All drains shall be checked for proper operation.

3-6. PROTECTION. Plumbing fixtures, equipment and appurtenances shall be protected from damage immediately after installation. Plumbing fixtures shall not be used during the construction.

3-7. CLEANING. After completion of testing and immediately before the final inspection, plumbing fixtures, equipment, piping, and appurtenances shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer. All faucet aerators shall be removed, cleaned, and reinserted.

Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3-8. DISINFECTION. Before the potable water system is placed in operation, it shall be disinfected in accordance with the requirements of the local authority having jurisdiction. In the absence of local requirements, the following disinfection method shall be used:

1. The system shall be purged with clean potable water until all dirt and other substances are flushed from the system.
2. The system shall be filled with a water/chlorine solution containing at least 50 parts per million [50 mg/L] of available chlorine and allowed to stand for 24 hours; or the system shall be filled with a water/chlorine solution containing at least 200 parts per million [200 mg/L] of available chlorine and allowed to stand for 3 hours.
3. The system shall be purged with clean potable water until the chlorine is flushed from the system.
4. The procedure shall be repeated if a bacterial examination indicates that contamination remains present in the system.

3-9. OPERATOR INSTRUCTION AND TRAINING. Not used.

End of Section

Section 15500

HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of heating, ventilating, and air conditioning (HVAC) equipment, devices, and appurtenances associated with the HVAC systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are needed, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1-2.05. Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1-2.06. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Makeup Air Units

- Name of manufacturer.
- Type and model.
- Construction materials, thickness, and finishes.
- Input and output heating capacities.
- Filter velocities.
- Overall dimensions and required clearances.
- Net weight and load distribution.
- Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute [m3/s] as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotative speeds on a single chart.
- Certified AMCA standard test code sound power output data for the fan outlet

and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

Electrical requirements including voltage, number of phases, and amperage.

Where specified, information on equipment manufacturers' representatives.

Fans

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute [m3/s] as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Where specified, information on equipment manufacturers' representatives.

Equipment (not specifically listed)

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Sheet Metal Ductwork

Sheet metal duct fabrication drawings indicating dimensions of individual shop and field fabricated sections, top and/or bottom duct elevations, joint locations, and dimensions of duct from walls or column rows.

Pressure and seal classifications.

Reinforcement types and spacing.

Joint and seam types.

Hanger and support types, spacing, and attachment methods.

Access panel and door construction, sizes, and locations.

Duct sealant, adhesive, gasket, and tape information.

Coatings.
Ductwork materials and thicknesses.
Product data demonstrating compliance with ASHRAE 62.1

Temperature Controls

Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.

Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring with all terminals accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

Sequence of operation for each system corresponding to the control schematics.

Space thermostat schedule indicating the types of covers and means of adjustment for each space.

Conduit and wire types.

Where specified, information on equipment manufacturers' representatives.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1-4. QUALITY ASSURANCE. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with

the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

Gas fired equipment shall be suitable for operation with the gas inlet pressure range specified in the individual equipment paragraphs.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve to the left of the peak pressure/efficiency point.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet [0.9 m] of clear access space shall be provided on all sides of the unit unless otherwise indicated.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet [610 m] above sea level shall be properly derated to operate and

meet the specified capacities at the site conditions.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MATERIALS.

2-4.01. Gas Vent Systems. Not used.

2-4.02. Packaged Air Handling Units. Not used.

2-4.03. Furnaces. Not used.

2-4.04. Makeup Air Units. Makeup air units, denoted by the symbol "MAU" and an identifying number, shall be 100 percent outside air, constant volume type, and shall be completely assembled, wired, and tested at the factory. Electric units shall be Hastings HVAC, Inc. “SBE”, Greenheck “Model MSX” or Engineered Air “LMK”.

Where indicated in the schedules on the Drawings, makeup air units including sensor and control elements shall be given a special coating resistant to the corrosive atmosphere indicated.

2-4.04.01. Extra Materials.

Extra Materials	Quantity
Sets of matched belts per unit	1
Sets of air filters per unit	2

2-4.04.02. Construction. The casing of the makeup air unit shall be of sectionalized construction consisting of a fan section, heating section, filter section, and, when located outdoors, an inlet hood. The unit housing shall be constructed of heavy gage galvanized paint grip carbon steel or aluminized steel, braced and reinforced with steel framework as needed for the operating pressures. The cabinet and casing shall be provided with the manufacturer's standard enamel finish. Gasketed access panels or hinged doors with lever type handles shall be furnished to provide access to all internal components.

The fan, heating, and accessory sections shall be internally insulated with 1 inch [25 mm] thick, 1-1/2 pound per cubic foot [24 kg/m^3] density mat-faced cleanable fiberglass insulation securely fastened to the panels. When available, the heating section shall be internally insulated with 1 inch [25 mm] thick, 1-1/2 pound per cubic foot [24 kg/m^3] density foil-faced fiberglass insulation. Where the insulation is not installed below the floor, the insulation shall be protected by a metal liner. Surfaces in contact

with the airstream shall comply with the requirements of ASHRAE 62.1. The insulation shall meet the requirements of NFPA.

Makeup air units installed outdoors shall be of weatherproof construction, with roof panels overlapping the side panels on all sides. Seams in roof panels shall be constructed of triple-break seams or roof panels pitched for drainage. All exterior joints shall be factory sealed weather tight.

Makeup air units installed outdoors shall have a stormproof weather hood with birdscreen sized for 100 percent outside air mounted on the unit inlet. The hood shall include a two-position motorized control damper which opens when the unit is energized and closes when it is de-energized unless a discharge damper is indicated in the schedules on the Drawings. Where a discharge damper is indicated, only the inlet hood shall be provided.

2-4.04.03. Fan Section. The makeup air units shall be equipped with centrifugal fans with forward-curved or backward inclined blades which shall be dynamically balanced and tested after being installed in the factory assembled fan section. Bearings shall be heavy-duty, self-aligning, grease lubricated type for units with wheel diameters greater than 18 inches [460 mm] and permanently lubricated or grease lubricated for units with wheel diameters 18 inches [460 mm] and smaller.

Static pressure values indicated in the schedules are external to the complete unit. The heating section, filter, and housing losses are not included. An allowance of 0.35 inch water column [87 Pa] shall be used for filter losses.

2-4.04.04. Motor and Drive. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer's standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the Drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

Fan drive motors shall be as specified in the electrical paragraph.

Makeup air units with smaller than 10 horsepower [7.5 kW] motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower [7.5 kW] and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets.

2-4.04.05. Heating Section.

a. Direct Fired. Not used.

b. Indirect Fired. Not used.

a. Electric Coil Section. Heating coils shall be finned tube, zero clearance type, with 80 percent nickel and 20 percent chromium resistance elements.

Bushings for open coils shall be ceramic and terminals shall be stainless steel.

Elements for finned tubular coils shall be centered in steel tubes filled with compacted magnesium oxide and copper plated fins brazed to the tube. The assembly shall be finished with high temperature aluminum coating.

Controls shall be completely factory wired and shall include disconnecting backup and safety contactors, transformers, fusing, disconnect switch, automatic reset thermal cutout, manual reset thermal cutout, and differential pressure airflow switch. The heating coil shall be furnished with a silicone controlled rectifier (SCR) control unit. The SCR control unit shall be suitable for operation at 32 to 132 F and shall be solid-state proportioning type, designed to modulate the heater output from 0 to 100 percent. For heating coils over 50 KW, a vernier proportional control system can be used as an option. The vernier control system shall consist of an SCR control stage sized at 125 percent to 150 percent of the other electronic step controlled heating stages. The vernier stage shall be used to modulate the heating output between the step controlled stages providing fully proportional control over the entire heating coil capacity. The electric heat elements and controls shall be suitable for operation on 480 volts, 60 Hz, 3 phase power.

2-4.04.06. Filter Section. Filter sections for makeup air units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 350 feet per minute [1.5 m/s] at design conditions unless otherwise indicated in the schedules on the Drawings. Access doors shall be provided for removal of filters from either side of the section. The filters shall be 2 inch [50 mm] pleated type and shall conform to the Air Filters paragraph.

2-4.04.07. Controls. Each unit shall be furnished with a complete control system consisting of fan starters and overload devices, an airflow proving switch, control circuit fuses, and a factory installed integral disconnect switch. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect switch for field installation on the unit shall be provided. Controls shall be suitable for interfacing with and enacting the control sequence and concept indicated on the Drawings.

A factory installed electronic discharge air temperature sensor and controller shall be

provided. The controls shall include controls to lock out the heating section when the outside air temperature is above the outdoor air inlet sensor setpoint.

An equipment control panel, denoted by the symbol “ECP” and an identifying number, shall be furnished with the makeup air unit and located where indicated on the Drawings. The panel shall be NEMA Type 4X and shall allow for remote operation of the unit with a "Winter-Off-Summer" switch, a supply temperature setpoint adjustment, and indicating lights for fan on, heat, safety lockout, and dirty filters. Auxiliary contacts shall be provided for interlock of associated exhaust equipment.

2-4.04.08. Accessories. Makeup air units indicated or shown to be curb mounted shall be furnished with a metal mounting curb. The curb shall be constructed of 14 gage [1.90 mm] thickness zinc-coated steel with a nominal 2 by 4 inch [50 by 100 mm] wood nailer strip and with supply air opening were indicated on the Drawings. The curb shall be a minimum of 16 inches [400 mm] high. The curb shall be approved by the National Roofing Contractors Association.

2-4.05. Heaters. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the Drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2-4.05.01. Electric Duct Heaters. Not used.
2-4.05.02. Electric Unit Heaters. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the Drawings.

a. Electric Unit Heaters (heavy-duty). Electric unit heaters located in unclassified areas shall be Chromalox “LUH”, or Brasch. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the Drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the Drawings to be wall hung, a wall mounting bracket shall be provided.

b. Electric Unit Heaters (explosionproof). Not used.

c. Electric Unit Heaters (corrosion resistant). Where indicated on the Drawings to be corrosion resistant, unit heaters shall be manufactured by Chromalox “HD3D”, Ruffneck “CR1 Triton”, or Indeeco "Triad". Each heater shall include fan and motor assembly, operating and safety controls, disconnect switch, and shall be suitable for use with a single point power supply indicated in the schedules on the Drawings.

Heater elements shall be Type 304 or 316 stainless steel, fin tubular type, with stainless steel fittings forming a watertight seal between the elements and the junction box. Unit heater fan motors shall be totally enclosed, permanently lubricated ball bearing type designed to resist corrosion and moisture. The fan blades shall be epoxy coated aluminum and the heater housing shall be at least a 20 gage [0.91 mm] Type 304 stainless steel. Where indicated on the Drawings to be wall hung, a swivel wall mounting bracket shall be provided.

The controls shall include automatic reset thermal cutout, fan delay relay, built-in control and motor contactors, control transformer, and terminal block all housed in a NEMA 4X enclosure. A pilot light visible on the heater exterior shall indicate heater operation.

2-4.05.03. Gas Unit Heaters. Not used.

2-4.05.04. Wall Heaters. Not used.

2-4.06. Fans. Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the Drawings, and shall be UL listed. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1.

Each fan shall be complete with an electric motor, factory mounted safety disconnect switch with wiring to the motor, drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower [7.5 kW] motors and fixed sheaves for 10 horsepower [7.5 kW] and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

Fan drive motors shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the Drawings.

Fans indicated in the schedules on the Drawings to be spark resistant construction shall be suitable for installation in a NEC Class I, Division 1 and 2, Group D environment. The fan shall have an AMCA spark resistant construction classification Type A or better and be equipped with non-static belts.

The external static pressure values indicated in the schedules on the Drawings are external to the complete unit. Internal fan housing and when furnished, backdraft

damper and filter losses are not included. An allowance of 0.35 inch water column [87 Pa] shall be used for pleated filter losses.

A solid state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp [0.4 kW] to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

Where indicated in the schedules on the Drawings, fans shall be given a special coating resistant to the corrosive atmosphere indicated.

2-4.06.01. Extra Materials.

Extra Materials	Quantity
Sets of matched belts per fan	1
Sets of air filters per fan	2

2-4.06.02. Cabinet Fans. Not used.

2-4.06.03. Duct Fans. Duct fans, denoted by the symbol "DF" and an identifying number, shall be Greenheck "SQ/BSQ", PennBarry, or Loren Cook. Duct fans shall be of the centrifugal in-line type, and shall be direct or belt driven, as indicated in the schedules on the Drawings. Fan wheels shall be aluminum, backward inclined type, dynamically and statically balanced at the factory.

The fan housing shall be square, constructed of aluminum, and shall be furnished with duct mounting collars. Access doors or panels shall be provided for servicing internal parts without removing the fan from the ductwork. Vibration isolation units shall be provided for each unit. The interior of the fan housing shall be lined with 1 inch [25 mm] fiberglass duct liner.

Motors and drives shall be isolated from the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, relubricatable or permanently sealed bearings with a minimum L_{50} service life of at least 200,000 hours at the equipment's maximum cataloged operating conditions.

Flexible wiring leads shall be provided from the fan motor to the safety disconnect switch which shall be accessible for servicing without disconnecting the field wiring.

2-4.06.04. Power Roof Ventilators. Power roof ventilators, denoted by the symbol "PRV" and an identifying number, shall be Greenheck "G/GB", PennBarry "Domex", or Loren Cook "ACE".

Power roof ventilators shall be centrifugal roof mounted type and shall be direct or belt driven as indicated in the schedules on the Drawings. Fan wheels shall be aluminum, backward inclined type statically and dynamically balanced at the factory for quiet, vibration-free operation. Fan housings shall be constructed of aluminum and shall have an aluminum base of the self-flashing type, suitable for mounting on the curbs indicated on the Drawings. Each fan shall be complete with 1/2 inch [13 mm] mesh aluminum bird screen over all openings, and, where indicated in the schedules on the Drawings, a backdraft damper.

Motors and drives shall be mounted outside the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, relubricatable or permanently sealed bearings with a minimum L_{50} service life of at least 200,000 hours at the equipment's maximum cataloged operating conditions.

A safety disconnect switch shall be mounted in the hood. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect for field installation shall be provided.

2-4.06.05. Propeller Fans. Not used.

2-4.06.06. Utility Fans. Not used.

2-4.06.07. Wall Fans. Not used.

2-4.07. Roof Hoods. Not used.

2-4.08. Dampers.

2-4.08.01. Backdraft Dampers. Backdraft dampers, denoted by the symbol "BDD" not specified to be furnished with equipment, shall be Arrow United Industries "Type 655", or Ruskin "BD6". Backdraft dampers shall be constructed with a 1 by 4 inch by 0.081 inch thick [25 by 100 mm by 2 mm] extruded aluminum frame. Blades shall be at least 0.070 inch [1.75 mm] aluminum with blade edge seals mechanically locked to blade edge and aluminum shafts operating in synthetic bearings. The leakage rate shall not exceed 20 cubic feet per minute per ft^2 [102 L/s/m^2] when tested at 1 in wc [0.25 kPa] for all sizes 24 inches [610 mm] wide and above.

2-4.08.02. Control Dampers. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet [2.3 m^2] or with any blade dimension exceeding 48 inches [1200 mm] shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit. The leakage rate shall not exceed 4 cubic feet per minute per ft^2 [20 L/s/m^2] when tested at 1 in wc [0.25 kPa] for all sizes 24 inches [610 mm] wide and above.

Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

Control dampers shall be given a special coating identical to the coating applied to the connected ductwork and equipment.

a. Duct Mounted Control Dampers. Not used.

b. Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-40". Control damper frames shall be constructed of 4 by 1 inch [100 by 25 mm] 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch [100 mm] wide airfoil-shaped extruded aluminum.

c. Round Control Dampers. Not used.

2-4.08.03. Volume Control Dampers. Volume control dampers shall be denoted by the symbol "VCD".

Galvanized volume control dampers in round ductwork shall be Arrow United Industries "Type 200 VCRD", or Ruskin “Model MDRS25”. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type 1770", or Ruskin “Model MD35”. Rectangular volume control dampers shall be fabricated of 16 gage [1.52 mm] thickness galvanized steel, with a nominal 4 or 5 inch by 1 inch [100 mm or 125 mm by 25 mm] channel frame, and opposed operating blades. Round dampers shall be fabricated of galvanized steel, with a nominal 7 inch [178 mm] long, 22 gage [0.76 mm] thickness frame, and a minimum 20 gage [0.91 mm] thickness circular blade.

Aluminum volume control dampers in round ductwork shall be Arrow United Industries "Type 75", or Ruskin “Model CDRS25”. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type OBDPL-507", or Ruskin “Model CD51”. Round dampers shall be fabricated of aluminum, with a nominal 7 inch [178 mm] long, 0.080 inch [2 mm] thick frame, and a minimum 0.080 inch [2 mm] thick circular blade. Rectangular volume control dampers shall be fabricated with a 1 by 4 or 5 inch by 0.081 inch thick [25 by 100 or 125 mm by 2 mm] extruded aluminum frame and opposed operating blades. Blades shall be of .125 inch [3 mm] thick aluminum with aluminum shafts and ball bearings.

The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

2-4.09. Damper Operators. The damper operators shall be direct coupled or foot-mounted type. Each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

Each operator shall have sufficient torque to operate the connected control damper based on at least 130 percent of control damper area. Each damper operator shall have at least a 50 inch-pound [5.6 N-m] normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators or operators with a greater running torque shall be furnished to produce the torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the Drawings.

Where damper operators are installed in hazardous areas indicated on the Drawings, the operators shall be furnished and installed in explosionproof housings suitable for installation in an NEC Class I, Division 1 and 2, Group D area.
Two-position direct coupled electric damper operators shall be Belimo "NFBUP-S" or “AFBUP-S”, Honeywell "MS4100 Series", or Johnson Controls. Foot-mounted type electric damper operators shall be Honeywell "Model M4185", or Johnson Controls "Model M100".

Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac or the power supply available from the temperature control system furnished. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA enclosure with a rating equal to or better than the damper operator.

Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable for round shafts. The operators shall be suitable for direct mounting to shafts up to 1 inch [25 mm] and shall be complete with mounting brackets and damper position indicator.

Foot-mounted type two-position electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch [9.5 mm] square, double-ended drive shaft.

2-4.10. Air Outlet and Inlet Devices. Air outlet and inlet devices shall be manufactured by Titus, Tuttle & Bailey, or Price. Air outlet and inlet devices shall be furnished and

installed where indicated on the Drawings.

Where air outlet and inlet devices are installed in ductwork given a special coating, an identical coating shall be applied to the air outlet and inlet devices.

2-4.10.01. Ceiling Diffusers. Not used.

2-4.10.02. Registers and Grilles. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the Drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

2-4.11. Flexible Connections. Flexible connections located indoors shall be Ventfabrics "Ventglas". Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon".

Ductwork connections to the air handling equipment, and where indicated on the Drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches [76 mm] of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20 to 180°F [-29 to 82°C] and shall weigh at least 27 ounces per square yard [915 g/m^2].

Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10 to 250°F [-23 to 121°C] and shall weigh at least 24 ounces per square yard [814 g/m^2].

2-4.12. Air Filtration Equipment.

2-4.12.01. Pleated Air Filters. Pleated air filters shall be American Air Filter "AM-AIR 300X" or Farr "30/30". Filters shall be disposable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have a minimum efficiency reporting value (MERV) based on the ASHRAE 52.2 guidelines of at least MERV 6.

Two inch [50 mm] pleated air filters shall have at least 12 pleats per linear foot [0.3 m] and at least 4.2 square feet of media per square foot of filter area. [4.2 square meters

per square meter]. Two inch [50 mm] filters shall have a maximum initial resistance of 0.13 inch water column at 300 feet per minute [32 Pa at 1.5 m/s].

2-4.12.02. Side Access Filter Housings. Side access filter housings shall be American Air Filter "Access Air" or Farr "Model 4P Glide/Pack". Side access filter housings shall be single-stage, factory-fabricated of 16 gauge [1.52 mm] thickness galvanized steel and shall be equipped with flanges for connection to the ductwork. Access doors shall be 16 gauge [1.52 mm] thickness galvanized steel and shall be positioned to allow replacement of filters from either side of the housing. Filter housings and doors shall be insulated and of double-wall construction. Filter tracks shall be provided to accommodate nominal 2 inch [51 mm] thick disposable filters as described herein. Leakage at the rated airflow shall be less than 1 percent at a 3 inches wc [0.75 kPa] differential.

2-4.13. Draft Gauges. Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge".

Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch [89 mm] diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20 to 140°F [-7 to 60°C], and a range of 0 to 1.0 inch water column [0.25 kPa], with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves. When mounted across filters, the signal flag shall be set at 0.75 inch water column [190 Pa].

2-4.14. Sheet Metal Ductwork. Ductwork, accessories, bracing, and supports shall be constructed of aluminum. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards unless otherwise indicated. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork.

Aluminum ductwork shall be constructed of aluminum alloy 3003-H14 or better in accordance with ASTM B209.

Plenums shall be constructed of reinforced 0.08 [2.03 mm] thickness aluminum sheet metal.

Sheet metal fan boxes shall be fabricated with 0.125 inch [3.175 mm] thickness aluminum sheet metal skin and structural framing of sufficient strength to support the fan box and the fan mounted on the box. Drawings of the fan boxes shall be submitted in accordance with the Submittals Procedures section.

Sealants shall be suitable for the duct service and shall maintain leakage integrity at pressures in excess of the ductwork pressure classification.

Where indicated on the Drawings, ductwork and accessories shall be given a special coating resistant to the corrosive atmosphere indicated. Where no special coating for ductwork is indicated, the coating shall be as specified in the Protective Coatings and Architectural Painting sections.

2-4.15. Duct Insulation. Interior duct liner shall be Knauf "Sonic XP Duct Liner", CertainTeed "ToughGard R", or Johns Manville " Linacoustic RC ".

Interior duct liner shall be 1-1/2 pound per cubic foot [24 kg/m^3] density, spray coated duct liner with an "R" value of at least 4.2 ft^2 hr F/BTU [0.74 m^2°C/W] per inch [25 mm] thickness at 75°F [24°C]. The insulation shall be suitable for temperatures up to 250°F [121°C] and shall have at least a 0.55 NRC per 1 inch [25 mm] thickness. The insulation shall conform to ASTM C1071. The insulation surface shall be resistant to microbial growth in accordance with UL 181, ASTM C1338, or comparable test method and shall be cleanable in accordance with NAIMA recommended practices.

2-4.16. Flexible Duct and Takeoffs. Not used.

2-4.17. Access Doors. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Insulated doors shall be insulated with the same thickness insulation as the duct in which it is installed. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

2-4.18. Temperature Controls. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; or Siemens Building Technologies, Landis Division. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2-4.18.01. Performance and Design Requirements. Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. Where cable and conduit is not indicated on the Drawings but is needed for a complete and functional control system in accordance with the sequence of operation it shall be provided as specified herein. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation.

Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper actuators, thermostats, temperature control panels, pressure differential switches, control

switches, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the Electrical Wiring paragraph. Cable and conduit for all HVAC power circuits shall be as specified in the Electrical section.

2-4.18.02. Tolerances. Unless otherwise indicated, the controls shall maintain space temperatures within ±2°F [1.1°C], and the relative humidity within ±5 percent of the setpoint.

2-4.18.03. Thermostats. Where indicated on the Drawings, thermostats shall be constructed of materials resistant to or shall be protected from the corrosive atmosphere indicated. Thermostats specified in the individual equipment paragraphs shall be provided with the respective equipment.

a. Two Position Wall Mounted Thermostats. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch", Penn Controls "A19BAC-1", or Siemens Building Technologies.

   Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F [2°C to 38°C] with a nonadjustable differential of 3.5°F [2°C]. The thermostats shall have a spdt switch rated for 1 horsepower [0.746 kW].

b. Two Position Corrosion Resistant Wall Mounted Thermostats. Two position wall mounted thermostats located in wet or corrosive environments shall be Honeywell "T631F".

   Two position corrosion resistant wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F [2°C to 38°C] with a nonadjustable differential of 3.5°F [2°C]. The thermostats shall have a spdt switch rated for 1 horsepower [0.746 kW].

c. Low Limit Thermostats. Low limit thermostats shall be Honeywell "L480", Penn Controls "Model A11B-1", or Siemens Building Technologies.

   Low limit thermostats used for low temperature cutout shall be capillary, line-voltage type, complete with spst switches. The sensing elements shall be at least 20 feet [6 m] long. The thermostat shall be responsive to the lowest temperature along the measuring element, shall have a range of approximately 35°F to 45°F [2°C to 7°C], and shall be automatically reset.

d. Modulating Duct Mounted Thermostats. Not used.

e. Explosion-proof Thermostats. Not used.

f. Programmable Wall Mounted Thermostats. Programmable, wall mounted thermostats shall be Honeywell "Model T7300", Penn Controls, or Siemens Building Technologies.

Programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45°F to 95°F [7°C to 35°C] with the following features:

- 7 day programming with 2 occupied/unoccupied periods per day.
- Automatic heat/cool changeover.
- Battery backup.
- Setback controls to automatically restart and temporarily operate system during setback periods.
- Digital display.
- Temporary override of setpoints.
- 2 configurable LED's.
- Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

2-4.18.04. Temperature Control Panels. Not used.

2-4.18.05. Dial Thermometers. Not used.

2-4.18.06. Smoke Detectors. Not used.

2-4.18.07. Pressure Differential Airflow Switches. Pressure differential airflow switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the Drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Switches used for proving airflow shall be selected with the lowest operating range such that the switch activates at 50 percent of the system airflow. Differential switches shall be UL listed.

Where indicated on the Drawings, pressure differential switches shall be provided with an explosion-proof housing suitable for a NEC Class 1, Division 2, Group D environment. Where differential pressure switches are located outdoors, a NEMA 4 rated weather enclosure shall be provided.

Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800". Explosion-proof pressure differential airflow switches shall be Dwyer Instruments, Inc. “Series 1950G”. Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter.

The switch shall be spdt, shall be rated 10 amperes at 120 volts ac and for a temperature range of 0°F to 125°F [-18°C to 52°C], and shall be provided with corrosion resistant mounting brackets. Unless otherwise indicated on the Drawings, initial setpoints of pressure differential switches located across filters shall be 0.75 inch

water column [190 Pa] to alarm high filter pressure loss and 0.1 inch water column [25 Pa] when mounted in air systems to alarm ventilation failure.

2-4.18.08. Control Stations. Not used.

2-4.18.09. Emergency Ventilation Shutoff Switches. Not used.

2-4.18.10. Accessory Components. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2-4.18.11. Electrical Wiring. Detailed wiring diagrams shall be submitted in accordance with the Submittals Procedures section. The wiring diagrams shall show the internal connections of the control panels and all field wiring to equipment remote from the control panels including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation.

Control wiring shall be in accordance with the National Electric Code (NEC). Cable shall be multi-conductor, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations.

Conduit for all HVAC control circuits in indoor locations shall be furnished and installed under this section. Conduit type shall be as specified in the Electrical Section.

2-5. ELECTRICAL. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2-6. DRIVE UNITS. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2-7. MANUFACTURE AND FABRICATION. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2-8. SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2-9. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3-2. PREPARATION.

3-2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3-2.02. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Architectural Painting andProtective Coatings sections.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Gas fired equipment furnished with pressure regulators that require a vent shall have an independent vent routed to outside. The vent shall be designed to prevent the entry of water or foreign objects.

The space beneath baseplates shall be grouted as specified in the Grouting section.

During construction, control measures as outlined in SMACNA IAQ Guidelines for Occupied Buildings under Construction shall be applied before the operation of any fan system.

All adhesives used on the interior of the building defined as inside the weatherproofing system shall have a VOC content not greater than 80 g/L.

3-3.01. Gas Vents. Not used.

3-3.02. Packaged Air Handling Units. Not used.

3-3.03. Furnaces. Not used.

3-3.04. Makeup Air Units. Flexible connections shall not be in tension when the fans are operating. Curb mounted units shall be firmly anchored to the equipment curbs with corrosion resistant fasteners.

3-3.05. Heaters. The bottom elevation of unit heaters shall be 8 feet [2.4 m] above finished floor unless otherwise indicated.

3-3.06. Fans. Where indicated on the Drawings, flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

3-3.07. Roof Hoods. Not used.

3-3.08. Damper Operators. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or

actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

The damper operator shall be installed to prevent entry of moisture from contacting internal parts. Conduit shall enter the operator from below or horizontally and incorporate a drip leg to prevent water from following the conduit into the operator interior.

The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position.

3-3.09. Air Outlet and Inlet Devices. Air outlet and inlet devices shall be installed level and plumb and in accordance with the manufacturer's written instructions.

3-3.10. Draft Gauges. Draft gauges for filters located more than 8 feet [2.4 m] above the finished floor shall be mounted on the nearest wall, 5.5 feet [1.7 m] above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

3-3.11. Sheet Metal Ductwork. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards unless otherwise indicated. The locations, arrangement, and sizes of ductwork shall be as indicated on the Drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch [0.25 kPa].

Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards in accordance with the following:

	Duct Type			
	Supply		Exhaust	Return
Duct Location	≤ 2 inches wc [0.5 kPa]	> 2 inches wc [0.5 kPa]		
Outdoors	A	A	A	A
Unconditioned Areas	B	A	B	B
Conditioned Spaces				
(concealed ductwork)	C	B	B	C
(exposed ductwork)	A	A	B	B

Sealing Levels
A - All transverse joints, longitudinal seams, and duct wall penetrations
B - All transverse joints and longitudinal seams
C - Transverse joints only

All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

Ductwork shall be supported as required by SMACNA. Where ductwork is connected to equipment, it shall be independently supported with no weight bearing on the equipment and in such a manner that the equipment maybe removed for service without temporary support of the ductwork. Ductwork shall be supported within 24 inches [600 mm] of each elbow and within 48 inches [1200 mm] of each branch intersection. Strap or wire hangers shall not be used where the hanger length exceeds 5 feet [1.5 m].

Ductwork shall be constructed and installed in accordance with the Drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet [2.4 m] above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch [200 mm] lighting allowance between the ceiling and the bottom of the ductwork.

In vertical ducts with a closed bottom which terminate less than 24 inches [600 mm] above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch [12.5 mm] drain hole in the bottom of the duct.

Turning vanes shall be installed in all elbows with 45 degree or greater angles. Vanes shall be double thickness or a minimum 4.5 inch [113 mm] radius type for vanes 30 inches [762 mm] and longer, where installed in ducts with velocity greater than 2000 fpm [10 m/s], or where installed in ducts with a pressure classification greater than 2 inches wc [0.5 kPa]. Where 4.5 inch [113 mm] or double thickness type turning vanes are required, each vane shall be welded to the vane runner.

3-3.12. Duct Insulation. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces which are to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall have the manufacturer's stamp or label bearing the name of the manufacturer and description of the contents.

Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches [200 mm] on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

The following ducts shall be insulated with interior duct liner unless indicated on the Drawings to be wrapped or otherwise indicated:

Location	Ductwork	Insulation Thickness
Exterior	a. All ductwork	2 inches [50 mm]
Interior within conditioned space (heated or cooled)	a. Heating supply and return	1 inch [25 mm]
	b. Cooling supply and return	1 inch [25 mm]
	c. Heating and cooling supply and return	1 inch [25 mm]
	d. Makeup air outside area served	1 inch [25 mm]
	e. Outside air (including plenums)	1.5 inches [37 mm]
Interior within unconditioned	a. Heating supply and return	1.5 inches [37 mm]

space	b. Cooling supply and return	1.5 inches [37 mm]
	c. Heating and cooling supply and return	1.5 inches [37 mm]
	d. Makeup air outside area served	1.5 inches [37 mm]
	e. Outside air (including plenums)	2 inches [50 mm]
Note: Exhaust systems shall not be internally lined.		

3-3.13. Flexible Duct and Takeoffs. Not used.

3-3.14. Access Doors. Airtight access doors shall be provided for inspection of all dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the Drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches [200 mm] square for hand access, 18 inches [450 mm] for shoulder access, or as indicated on the Drawings. Each access door shall be installed to open against the pressure in the duct.
Access doors shall be installed to allow for inspection, cleaning, and maintenance of the ductwork. Doors shall be installed on each side of elbows with turning vanes and along the duct at a maximum 50 foot [15 m] spacing.

3-3.15. Temperature Controls. Automatic temperature controls shall be furnished and installed as indicated on the Drawings and as specified herein.

Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the Drawings. Control equipment shall be installed with adequate space for operating and maintenance access.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-3.15.01. Temperature Control Panels. Not used.

3-3.15.02. Thermostats. Wall-mounted thermostats shall be mounted above the finished floors as indicated in the Electrical section. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

Wall-mounted thermostats in non air-conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. An installation check by an authorized representative of the manufacturer is not required for equipment specified in this section.

3-4.02. Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3-5. CLEANING. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

Section 15650

REFRIGERATION SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of packaged air conditioning / heat pump units, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products

specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1 and the latest local energy code, unless otherwise indicated on the Drawings.

Capacity ratings for condensing units, and packaged air conditioning units with capacities less than 135,000 BTUH [39 kW] shall be in accordance with AHRI Standard 210/240. For condensing units, and packaged air conditioning units with capacities over 135,000 BTUH [39 kW] the capacity ratings shall be in accordance with AHRI Standard 340/360.

1-2.05. Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

1-2.06. Metal Thickness. Metal thickness and gauges specified herein are minimum requirements. Gauges refer to US Standard gauge.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Packaged Air Conditioning / Heat Pump Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Net weight and load distribution.

Multiline wiring diagrams clearly indicating field installed and factory installed wiring with all terminals identified.

Electrical requirements including voltage, number of phases, and amperage.

Where specified, information on equipment manufacturers' representatives.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1-4. QUALITY ASSURANCE. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part

nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

For equipment including fans, each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet [0.9 m] of clear access space shall be provided on all sides of the unit unless otherwise indicated.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet [610 m] above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MATERIALS.

2-4.01. Refrigerant Piping and Accessories. Not used.

2-5. EQUIPMENT.

2-5.01. Condensing Units. Not used.

2-5.02. Room Air Conditioner. Not used.

2-5.03. Packaged Air Conditioning / Heat Pump Units. Packaged air conditioning units, denoted by the symbol “PAC” and an identifying number, and packaged heat pumps, denoted by the symbol "PHP" and an identifying number, shall be furnished and installed where indicated on the Drawings. Each unit shall be designed for outdoor installation on a full perimeter curb as indicated on the Drawings. The packaged air conditioning unit shall be manufactured by Trane, Carrier, McQuay, or York.

The manufacturer of the equipment provided shall have a local service center.

2-5.03.01. Extra Materials.

Extra Materials	Quantity
Complete changes of lubricating oil	1
Sets of air filters	2

2-5.03.02. Performance and Design Requirements. The units shall be completely factory assembled and tested, piped, internally wired, fully charged with R-410A and compressor oil, and shipped in one piece. The unit shall be designed for direct expansion cooling and configured for heating type indicated. The unit shall be suitable for the power supply and shall have the capacities indicated on the Drawings. Cooling capacities listed in the schedule are gross cooling capacity.

The refrigeration system shall be capable of satisfactory cooling operation at the maximum and minimum outdoor ambient air temperatures indicated on the Drawings. Where units need to operate in the cooling mode at a lower temperature than the factory standard as indicated in the schedules on the Drawings, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F [-18°C] consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature.

Where indicated in the schedules on the Drawings, all copper and other surfaces subject to corrosion from the atmosphere indicated shall be given a special coating.

2-5.03.03. Casing. The unit casing shall be of weatherproof design and shall be constructed of 20 gage [0.91 mm] or heavier zinc-coated steel. The casing shall be properly reinforced and braced for maximum rigidity. The casing shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard baked enamel finish. Interior surfaces of exterior casing members in contact with the airstream shall have 1 inch [25 mm] thick, 1 pound [454 kg] density, insulation coated on the air side. Aluminum foil-faced glass fiber insulation shall be used in gas fired heating sections. Hinged, insulated, neoprene gasketed

access doors or removable panels shall be provided to permit easy inspection and maintenance. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1. Removable insulated access panels shall have aluminum or steel covering on the interior to protect the insulation. The unit base shall be a one-piece, welded assembly with suitable roof curb sealing gasket and curb overhang for water runoff. Drains shall be provided to accommodate outdoor coil runoff.

2-5.03.04. Indoor Coil Section. The indoor coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory leak tested underwater at 200 psig [1380 kPa gauge]. The coil shall be provided with expansion device or valve, filter-dryer, and moisture indicator. The indoor coil section shall have fully insulated, sloped drain pan extending under the entire coil section and extending sufficiently past the coil to capture and collect any condensate carryover that may be produced when the unit is operating within the specified operating conditions. The drain pan construction shall comply with the requirements of ASHRAE 62.1.

2-5.03.05. Heating Sections. The unit shall have a heating section of the type scheduled on the Drawings.

Electric coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code. The heating coil shall have the minimum number of stages indicated in the schedules on the Drawings.

2-5.03.06. Filters. Filters shall be mounted integral within the packaged air conditioning unit and shall be 2 inches [50 mm] thick. Hinged access doors shall be provided. Filters shall conform to the requirements in the Heating, Ventilating, and Air Conditioning Systems section .

2-5.03.07. Fans and Motors. The indoor supply fan shall be forward-curved, multiblade, centrifugal type and shall be statically and dynamically balanced by the fan manufacturer. The fan shall have die-formed, streamlined inlets and the scroll shall be constructed of steel with all seams sealed airtight. The fan shall have steel shafts operating in self-aligning, grease lubricated ball bearings.

Units 5 tons [17.5 kW] and smaller shall have direct or belt driven fans as shown on the Drawings. Where direct driven fans are used, the fan shall have multiple speeds to allow for airflow adjustment. Units greater than 5 tons [17.5 kW] shall have V-belt drive with adjustable sheaves and shall be designed for 50 percent overload. The supply fan motor shall conform to the requirements of the Electric Motors paragraph. Vibration isolators shall be provided for the fan assembly and motor assembly.

Static pressure values indicated on the Drawings are external to the complete unit.

Internal coil(s), dampers, filters and fan housing losses are not included. A filter allowance of 0.35 inch water column [0.087 kPa] shall be used for 2 inch [50 mm] pleated filter losses.

The outdoor fans shall be direct drive, vertical discharge, propeller type with aluminum blades. Fan motors shall be weatherproof with permanently lubricated ball bearings and built-in thermal overload protection. A corrosion resistant wire guard shall be installed over the fan opening.

2-5.03.08. Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Each packaged air conditioning unit shall have a minimum number of capacity reduction steps as indicated in the schedules on the Drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2-5.03.09. Refrigerant Circuit. The factory sealed refrigerant system shall consist of compressors, outdoor coils, indoor coils, expansion device, refrigerant dryer, accumulators, refrigerant piping, and a full operating charge of refrigerant. Units with multiple stages shall have a separate refrigerant circuit for each stage where available as a manufacturer's standard option. Service gauge connections shall be furnished on the suction, discharge, and liquid lines. Units with multiple compressors shall have multiple circuits with separate expansion device, refrigerant dryer, accumulators, compressor, and refrigerant charge. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

2-5.03.10. Outdoor Coil. The outdoor coil shall be of the air-cooled integral finned tube type. The coil shall be constructed of copper tubes with aluminum fins permanently and securely bonded to the tubes. The coil shall be factory leak and pressure tested. The coils shall be protected with hail guards.

2-5.03.11. Accessories. Where indicated on the Drawings, hot gas bypass shall be installed to provide reduced capacity control.

Packaged units shall be furnished with a metal mounting curb. The curb shall be constructed of at least 16 gauge [1.52 mm] zinc-coated steel with nominal 2 by 4 inch [50 by 100 mm] wood nailer strip and with supply and return air openings. The curb shall be a minimum of 16 inches [405 mm] high. The curb shall be approved by the National Roofing Contractors Association.

2-5.03.12. Controls. Each packaged unit shall be completely factory wired with a single point power connection and factory installed integral disconnect switch. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect switch for field installation on the unit shall be provided. All wiring shall be installed in accordance with the National Electrical Code.

Packaged units shall be provided with a programmable controller capable of providing lead/lag control where indicated on the Drawings.

Packaged units shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor, outdoor fan, and indoor fan motors, and internal control power transformer.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat; terminal points to energize remote dirty filter, heating mode, cooling mode, and service indicating lights; and terminal points to de-energize the unit upon detection of smoke.

A thermostat for operation of the unit shall be furnished and installed as indicated and located where indicated on the Drawings. The thermostat shall be a programmable wall mounted type and shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional system. The thermostats shall have a setpoint range of approximately 45°F to 95°F [7°C to 35°C] with the following features:

- 7 day programming with 2 occupied/unoccupied periods per day.
- Automatic heat/cool changeover.
- Battery backup.
- Setback controls to automatically restart and temporarily operate system during setback periods.
- Digital display.
- Temporary override of setpoints.
- 2 configurable LED's.
- Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

2-5.04. Ductless Split Systems. Not used.

2-5.05. Water Chillers. Not used.

2-6. ELECTRICAL. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2-7. DRIVE UNITS. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2-8. MANUFACTURE AND FABRICATION. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2-9. SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2-10. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3-2. PREPARATION.

3-2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3-2.02. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath the baseplate shall be grouted as specified in the Grouting section.

3-3.01. Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the valve sections.

3-3.02. Refrigerant Piping and Accessories. Not used.

3-3.03. Condensing Units. Not used.

3-3.04. Packaged Air Conditioning / Heat Pump Units. The packaged air conditioning units and heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored to the equipment curbs with corrosion resistant fasteners.

3-3.05. Ductless Split Systems. Not used.

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. An installation check by an authorized representative of the manufacturer is not required for equipment specified in this section.

3-4.02. Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable

3-4.03. Operator Instruction and Training. Not used.

3-5. CLEANING. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

Section 15990

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1-1. SCOPE. This section covers the cleaning, testing, adjusting, and balancing of the air system(s) associated with the heating, ventilating, and air conditioning (HVAC).

1-2. GENERAL. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.

Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

1-2.02. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air systems.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete apparatus report sheets for all air systems shall be accurately and completely filled out in accordance with the Standard's manual. The testing and balancing results shall be submitted on the TAB report forms of the applicable standard. Copies of the final test readings and report sheets shall be submitted in accordance with the Submittals Procedures section. A description of the standard procedures used during testing, adjusting, and balancing shall be included in the submittal. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets. Test dates shall be recorded on the individual TAB report forms indicating when the actual testing was performed.

The apparatus report sheets shall include the following information:

1. Title Page:
    a. Company name
    b. Company address
    c. Company telephone number
    d. Project name
    e. Project location
    f. Project Engineer
    g. Project Contractor
    h. Project altitude
    i. Date
2. Instrument List:
    a. Instrument
    b. Manufacturer
    c. Model
    d. Serial number
    e. Range
    f. Calibration date
3. Air Moving Equipment:
    a . Unit number
    b. Location
    c. Manufacturer
    d. Model and serial number
    e. Airflow, design and actual
    f. Total static pressure (total external), design and actual
    g. Static pressure, inlet and discharge
    h. Total pressure
    i. Fan RPM, design and actual
4. Electric Motors:
    a. Manufacturer
    b. Motor type and frame
    c. HP/BHP
    d. Phase, voltage, amperage, nameplate, actual, no load.
    e. RPM
    f. Service factor
    g. Starter size, rating, heater elements
5. V-Belt Drive:
    a. Required driven RPM
    b. Driven sheave make, diameter, and RPM
    c. Belt make, size, and quantity
    d. Motor sheave make, diameter, and RPM
    e. Center to center distance, maximum, minimum, and actual
6. Return Air/Outside Air Data:
    a. Unit number
    b. System airflow, design and actual
    c. Return airflow, design and actual

d. Outside airflow, design and actual
e. Return air temperature
f. Outside air temperature
g. Mixed air temperature, design and actual
h. Outside/return air ratio, design and actual

7. Coil Data: Not used.
8. Duct Traverse:
   a. System zone/branch
   b. Duct size
   c. Area
   d. Velocity, design and actual
   e. Airflow, design and actual
   f. Duct static pressure
   g. Air temperature
   h. Air correction factor
9. Outlet and Inlet Devices:
   a. Air outlet and inlet device number
   b. Room number/location
   c. Air outlet and inlet device type
   d. Air outlet and inlet device size
   e. Area factor
   f. Velocity, design, preliminary, and final
   g. Air flow, design, preliminary, and final
   h. Percent of design airflow
10. Sound Level Report:
    a. Location
    b. Octave bands - equipment off
    c. Octave bands - equipment on
11. Package Heat Pump.
    a. Unit number
    b. Location
    c. Manufacturer and model
    d. Refrigerant type and capacity
    e. Airflow, design and actual
    f. Return airflow, design and actual
    g. Outside airflow, design and actual
    h. Dry bulb temperature, entering and leaving
    i. Wet bulb temperature, entering and leaving
    j. Outside air temperature, dry and wet bulb
12. Air Terminal Unit Data: Not used.
13. Electric Duct Heater: Not used.
14. Air Cooled Condenser: Not used.
15. Chillers: Not used.
16. Pump Data: Not used.
17. Heat Exchanger: Not used.

18. Combustion Test: Not used.
19. Odor Control Vessels: Not used.
20. Mist Eliminators: Not used.

1-4. QUALITY ASSURANCE. Contractor shall provide the services of a licensed independent contractor, certified by AABC, NEBB, or TABB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air systems. The work shall be performed in accordance with the latest edition of the procedural standards as published by the National Organization associated with the testing, adjusting, and balancing contractor.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the equipment sections.

2-2. CONSTRUCTION.

2-2.01. Painting. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Architectural Painting andProtective Coatings sections.

PART 3 - EXECUTION

3-1. INSPECTION. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed where applicable. Fans shall be checked for correct rotation and rotative speed. Dampers shall be open and access doors and panels shall be closed during the testing and balancing period.

A resistance shall be placed at all filter locations to simulate dirty filter conditions. The filter resistance shall be as follows:

Filter Type	Simulated Loss
2 inch [50 mm] pleated	0.35 inch water column [87 Pa]

3-2. STARTUP REQUIREMENTS. System equipment shall be subject to preliminary field tests as indicated in Startup Requirements section.

3-3. FIELD PERFORMANCE TESTING. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material shall be

replaced, and the inspection and tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

Filter Type	Dirty Filter Conditions
2 inch [50 mm] pleated	1 inch water column [250 Pa]

3-3.01. Hydronic Piping. Not used.

3-3.02. Refrigerant Piping. Not used.

3-4. CLEANING. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3-4.01. Chemical Pipe Cleaning. Not used.

3-5. ADJUSTING & BALANCING. The air systems shall be adjusted and balanced.

All instrumentation shall be calibrated in accordance with the governing standard manual and shall be checked for accuracy before testing, adjusting, and balancing the systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.

All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.

Following final acceptance of the certified balancing reports, the testing and balancing contractor shall permanently mark the settings of all adjustment devices, including valves and dampers, and shall lock the memory stops.

All ceiling tiles, belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.

3-5.01. Air Systems. Air systems shall be adjusted to the design airflows indicated on the Drawings. Airflows shall be adjusted to maintain a net positive (supply airflow greater than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the Drawings. Dampers located behind air outlet and inlet devices shall be used to adjust the airflow only to the extent that the adjustments do not

create objectionable air movement or noise. Fans shall not be adjusted above the maximum safe speed as determined by the fan manufacturer.

Dampers with operators shall be checked for tight shutoff when in the closed position. Shutoff dampers shall not be used for balancing.

End of Section

Section 16050

ELECTRICAL

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.

This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

This section covers installation of equipment furnished by Owner.

1-2. GENERAL. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Coordination. Electrical work shall conform to the construction schedule and the progress of other trades.

1-2.04. Anchor Bolts and Expansion Anchors. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch 19 mm will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

1-2.05. Drawings. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1-3. CODES AND PERMITS. All work shall be performed and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

ANSI	American National Standards Institute.
ASTM	American Society for Testing and Materials.
AWG	American Wire Gauge.
Fed Spec	Federal Specification.
ICEA	Insulated Cable Engineers Association.
IEEE	Institute of Electrical and Electronics Engineers.
IESNA	Illuminating Engineering Society of North America.
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association.
NFPA	National Fire Protection Association.
UL	Underwriters' Laboratories.

Equipment covered by this section shall be listed by UL, or by a nationally recognized third party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. If no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to be used.

1-4. SEISMIC DESIGN REQUIREMENT.

1-4.01. Seismic Design Requirements. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-5. IDENTIFICATION.

1-5.01. Conduit. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 19 gage 1 mm thick stainless steel, with 1/2 inch 13 mm stamped letters and numbers as indicated on the Drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

All spare, unused, future and abandoned conduits shall be labeled with the conduit destination MCC, manhole number, pullbox, etc.

1-5.02. Conductors. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.

1-5.02.01. Conductor Identification Number. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at both origin and the point of termination.

The wire markers shall be of the plastic split sleeve or heat-shrinkable tube type, with custom typed identification numbers printed with a Brady TLS 2200 label machine. Labels shall be 1-inch “PSPT XXX-1W” Type or 1 3/4-inch “PSPT XXX-175W” Type as required by the number of characters.

Labeling shall be coordinated with the Owner and shall be no smaller than 10-pt. type. The wire numbers shall be as indicated on the equipment manufacturer's drawings. Wire labels for instrumentation and control wiring shall contain 2 lines of text. Line 1 of the label shall list the circuit number and the device or panel of origin as well as the terminal strip and terminal number. Line 2 shall list the device or panel of termination as well as the terminal strip and terminal number.

The wire markers shall be positioned to be readily visible for inspection.

1-5.02.02. Conductor Color Coding. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.

The following phase identification color coding system shall be used to identify ungrounded phase conductors A, B, and C and grounded phase conductor where applicable:

120/240V single-phase — black, red, and white
120/208V, three-phase — black, red, blue, and white
120/240V, three-phase — black, orange, blue, and white
277/480V, three-phase — brown, orange, yellow, and gray
2400/4160V, three-phase – black, red, blue, and white

Where 120/240 and 120/208 volt systems share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.

Control and instrumentation circuit conductors shall be color coded as indicated in the Cable Data Figures at the end of this section.

1-5.03. Motor Starters. Motor starters shall be provided with nameplates on the exterior of the enclosure door identifying the related equipment. Nameplates shall follow the established tagging convention of the respective plant and shall incorporate at a minimum the identification of the motor served, the horsepower, voltage, and phase rating. Pilot controls and indicating lights shall have engraved or etched legends "start", "stop", etc. as indicated on the Drawings. Nameplates shall be three-layer laminated plastic black letters over white background, with 1/8 inch 3 mm engraved letters, and shall be securely fastened to the motor starters. In addition to the above enclosure exterior identification criteria, also provide a typed label inside each motor starter enclosure door identifying the motor served and listing the motor nameplate data.

1-5.04. Control Stations. Control stations shall be provided with extra large nameplates identifying the specific function associated with the related equipment. Nameplates shall follow the established tagging convention of the respective plant. Pilot controls and indicating lights shall have engraved or etched legends "start", "stop", etc. as indicated on the Drawings; provide pushbutton stations with laminated plastic nameplates indicating the drive they control. Nameplates shall be three-layer laminated plastic black letters over white background, with 1/8 inch 3 mm engraved letters, and shall be securely fastened to the control stations.

1-5.05. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall follow the established tagging convention of the respective plant. Nameplates shall be three-layer laminated plastic black letters over white background, with 1/8 inch 3 mm engraved letters, and shall be securely fastened to the circuit breakers.

1-5.06. Disconnect Switches. All switches shall have front cover-mounted permanent nameplates that include switch type, manufacturer's name and catalog number, and horsepower kW rating. Nameplates shall follow the established tagging convention of the respective plant. An additional nameplate, engraved or etched, three-layer laminated plastic black letters over white background, with 1/8 inch 3 mm letters, shall be provided to identify the associated equipment. Both nameplates shall be securely fastened to the enclosure.

1-5.07. Major Electrical Equipment. If not described in the above identification criteria, also provide nameplates for all switchboards, panelboards, transformers, disconnect switches, individual motor starters, and other items of electrical distribution equipment.

Nameplates shall be three-layer laminated plastic, black letters on white background. Engrave with the equipment identification as indicated, and the voltage rating. Attach nameplates with screws or rivets; adhesives are not acceptable.

1-5.08. Arc Flash Hazard Labels. Lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter socket enclosures, and other electrical equipment likely to be worked on energized shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment PPE required. SEE NFPA 70E. Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

Additional information shall be provided on the labels where specified in the Arc Flash Hazard Analysis section of this section.

1-6. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Drawings and data.
Operating manuals.
Samples.
Test reports
Studies

1-6.01. Submittal Identification. Information covering all materials and equipment shall be submitted for review in accordance with the Submittals Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.

b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.

c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.

d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.

e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

f. Surge protective device submittals shall include drawings including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams, equipment manuals that detail the installation, operation and maintenance instructions for the specified units, and manufacturer's descriptive bulletins and product sheets.

Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the protective device study and the on-site testing

Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.

In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

1-6.02. Seismic Design Requirements. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-7. PROTECTION AND STORAGE. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2-1. POWER SERVICE ENTRANCE. Not used.

2-2. TELEPHONE SERVICE ENTRANCE. Not used.

2-3. CABLE. All cables of each type such as lighting cable or 600 volt power cable shall be from the same manufacturer.

All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.

2-3.01. Lighting Cable. Not used.

2-3.02. 600 Volt Power Cable. Cable in lighting, receptacle, power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are required, shall be 600 volt Figure 2-16050 XHHW-2 power cable.

2-3.03. Instrument Cable. Cable for electronic circuits to instrumentation, metering, and other signaling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be Figure 4-16050 single pair.

2.3.04. Multiconductor Control Cable. Not used..

2-3.05. Medium Voltage Power Cable. Cable for circuits rated higher than 600 volts but not above 5,000 volts, and for wet or dry locations in conduit and open air, shall be Figure 9-16050 8 kV EPR power cable.

2-3.06. Tray Cable. Not used.

2-4. CONDUIT. Conduit and raceways shall be as described in the following paragraphs:

2-4.01. Rigid Steel Conduit. Rigid steel conduit shall be heavy wall, hot-dip galvanized, shall conform to ANSI C80.1, and shall be manufactured in accordance with UL 6.

2-4.02. Intermediate Metal Conduit IMC. Not used.

2-4.03. Liquidtight Flexible Metal Conduit. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moistureproof polyvinyl chloride jacket, and shall be UL labeled.

2-4.04. Utility PVC Duct. Utility duct with concrete encasement shall be polyvinyl chloride (ASTM F-512 designation DB-120) and shall conform to NEMA TC-6, NEMA TC-8, and ASTM F-512.

2-4.05. Rigid Nonmetallic PVC Conduit. PVC conduit shall be heavy wall, , UL labeled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL 651. Conduit shall be Schedule 40 PVC except for those areas identified on the drawings and described in these specifications as chemical areas which shall be Schedule 80 PVC.

2-4.06. PVC-Coated Rigid Steel Conduit. The conduit shall be rigid steel. Before the PVC coating is applied, the hot-dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils 1000 µm.

A chemically cured two-part urethane coating, at a nominal 2 mil 50 µm thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.

Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches 50 mm, whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils 1000 µm.

All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.

PVC coated rigid steel conduit shall be manufactured by Ocal, Perma-Cote, or Robroy.

2-4.07. Electrical Metallic Tubing EMT. Not used.

2-4.08. Rigid Aluminum Conduit RAC. Not used.

2-5. WIRING DEVICES, BOXES, AND FITTINGS. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

2-5.01. Conduit Boxes and Fittings.

a. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, or O Z Gedney. In applications utilizing aluminum conduit systems, aluminum boxes and fittings manufactured by Crouse-Hinds, Appleton, or O Z Gedney shall be installed.

b. Rigid PVC device boxes and fittings shall be manufactured by Carlon or Cantex.

c. Sheet steel device boxes shall be manufactured by Appleton, Raco, or Steel City.

d. PVC coated device boxes shall be manufactured by Calbond, Ocal, or Robroy Industries.

e. Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.

2-5.02. Device Plates.

a. Galvanized or cadmium-plated device plates shall be used on surface mounted outlet boxes where weatherproof plates are not required.

b. Device plates on flush mounted device and receptacle boxes where weatherproof plates are not required shall be AISI Type 302 stainless steel, Eaton "93000 series", Hubbell "S series", or Leviton "840nn-40 series"; nylon or polycarbonate, Eaton "5000 series", Hubbell "Pn series", or Leviton "807nn-I series".

c. Device plate mounting hardware shall be countersunk and finished to match the plate.

d. Device plates for switches outdoors or indicated as weatherproof shall have provisions for padlocking switches "On" and "Off", and shall be Appleton "FSK-1VS", Crouse-Hinds "DS185" or O Z Gedney "FS-1-WSCA".

e. Device plates for receptacles indicated as weatherproof shall be Appleton "FSK-WRD", Crouse-Hinds "WLRD1", or O Z Gedney "FS-1-WDCA.

f. Flush-mounted, weatherproof plates shall be provided with adapter plates, Appleton "FSK-SBA" or Crouse-Hinds "FS031".

g. Device plates for ground fault interrupter receptacles indicated to be weatherproof shall be Appleton "FSK-WGFI", Eagle "S966", or O Z Gedney "FS-1-GFCA".

h. Receptacle covers outdoors or otherwise indicated to be weatherproof while in-use shall be die cast aluminum and shall include a padlock eye. Covers for standard convenience outlets shall be Hubbell “WP8M” or Thomas and Betts Red Dot “CKMUV”. Covers for ground fault interrupter receptacles shall be Hubbell “WP26M” or Thomas and Betts Red Dot “CKMUV”.

i. Engraved device plates, where required, shall be manufactured by Leviton, or equal.

j. Device plates on PVC conduit fittings shall be Carlon "E98 Series" or Cantex "513300 Series".

2-5.03. Wall Switches.

a. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Eaton "AH1221V" through "AH1224V", Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I".

b. Switches for pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, center "Off", Eaton "1995V", Hubbell "1557I" or Leviton "1257-I".

c. Switches on ac lighting panel load circuits through 277 volts in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be 20 ampere, 120/277 volts. Hazardous area switches shall be factory sealed tumbler switches, Appleton “EDS” or Killark “FXS”.

2-5.04. Receptacles.

a. Standard convenience outlets shall be duplex, three-wire, grounding, 20 amperes, 125 volts, Eaton "AH5362V", Hubbell "5362I" or Leviton "5362-I" for 120 volt circuits, and 250 volts, Eaton "AH5462CV", Hubbell "5462I" or Leviton "5462-I" for 240 volt circuits.

b. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Eaton "SGFH20", Hubbell "GF5362I" or Leviton "7899-I".

c. Ground fault circuit interrupter receptacles in damp or wet locations shall be duplex, 20 amperes, 125 volts, Hubbell "GFWRST20I" or Leviton "WT899-HGI".

d. 600 volt welding receptacles shall be 30 amperes, 3 phase, with grounding conductors connected through a fourth pole, Appleton

"ADRE3034-100", Crouse-Hinds "AR348" plus "ARRC33" and "AR30" or Leviton " 430MI5W". One matching plug, Appleton "ACP3034BC", Crouse-Hinds "APJ3485" or Leviton "430P5W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

e. 240 volt welding receptacles shall be 60 amperes, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ADRE6034-150", Crouse-Hinds "AREA6425" or Leviton "460MI9W". One matching plug, Appleton "ACP6034BC", Crouse-Hinds "APJ6485" or Leviton "460P9W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

f. Receptacles in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be three-wire, grounding, 20 amperes, 125 volts. Hazardous area receptacles shall be factory sealed, with an integral switch that is only activated when an approved matching plug is fully inserted and rotated into the engaged position. Hazardous area receptacles shall be Appleton “ENR”, Crouse-Hinds “ENR”, or Killark “UGR”.

2-5.05. Special Outlets. Not used.

2-6. JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS. Indoor boxes larger than switch, receptacle, or fixture type and gutters shall be constructed of sheet steel, shall be galvanized after fabrication, and shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts. No junction box, pullbox or gutter shall be smaller than 6” x 6” by 4” deep.

Indoor boxes and gutters in corrosive areas indicated on the Drawings as Area Type 1A shall be fiberglass. Outdoor boxes and gutters shall be NEMA Type 4Xstainless steel and shall be rigidly supported by PVC-coated or stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

Junction boxes and pull boxes smaller than 16” x 14” by 6” deep shall have a quick release latch JIC Style similar to E-BOX, Model JQRL. Junction boxes and pull boxes larger than 16” x 14” by 6” deep shall have a quick release latch similar to E-BOX, Model N4QRL.

Bolt-on junction box covers 3 feet 900 mm square or larger, or heavier than 25 lbs 11 kg, shall have rigid handles. Covers larger than 3 by 4 feet 900 by 1200 mm shall be split.

Junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2-6.01. Terminal Junction Boxes. Provide hinged-cover terminal junction boxes of the required type and size where indicated on the drawings. Enclosures shall be sized based upon the number and diameter of conduit entries per the NEC. Provide terminal blocks with a separate connection point for each conductor entering or leaving the box. Provide metal back plate for mounted terminal blocks. Provide 20 percent spare terminal points. Paint interior surfaces with white enamel or lacquer. Label each block and terminal with a permanently attached, non-destructible tag.

Provide screw clamp compression, dead front barrier type terminal blocks with current bar providing direct contact with wire between the compression screw and yoke. Provide yoke, current bar, and clamping screws constructed of high strength and high conductivity metal. Utilize yoke that guides all strands of wire into the terminal. Utilize current bar providing dependable vibration-proof connection. Supply terminals constructed to allow connection of wire without any special preparation other than stripping. Rail mount individual terminals to create a complete assembly and provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

Size all terminal block components to allow insertion of wire sizes and types indicated on the drawings or as required. Supply terminal blocks with marking system allowing the use of preprinted or field-marked tags. Supply CSA certified and UL approved terminal blocks manufactured by Weidmuller, Ideal, Electrovert, or equal.

2-7. LIGHTING FIXTURES. Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. Lighting fixtures shall be furnished complete with lamps. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise specified. Lighting fixtures shall be provided with disconnects in accordance with NEC requirements.

2-7.01. Electronic Drivers. Electronic drivers furnished with LED type lighting fixtures shall be certified as meeting requirements of ANSI C82.77 with a THD level of not more than 20 percent.

2-8. LIGHTING PANELS. Each lighting panel shall be a dead-front, 120/240 volt, single phase or 120/208 volt, three phase panelboard with circuit breakers, in accordance with the Drawings and the following:

2-8.01. Cabinet. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed minimum of NEMA Type 12. Where the indoor area rating is identified as Area Type 4, the enclosure shall be rated NEMA 4X Type 316 stainless steel and if the panel cabinet rating cannot be obtained in NEMA 4X stainless steel, then the panel shall be mounted within an outer, larger NEMA 4X enclosure.

The enclosure shall have a hinged door as well as a hinged trim cover arranged as a door-in-door configuration. Breaker operating handles shall be accessible through a latched, lockable, door. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

2-8.02. Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip. Breakers shall have interrupting ratings not less than 10,000 amperes. Handle clips to prevent casual operation of breakers shall be provided for 10 percent at least two of the breakers and applied to the circuits directed. Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings indicated on the Drawings.

Where indicated on the Drawings, circuit breakers shall include arc-fault circuit interrupter AFCI and/or ground fault circuit interrupter GFCI protection functions. Where GFCI breakers dedicated to protect heat tracing circuits, GFCI breakers shall be configured for equipment protection with a ground fault trip threshold of 30 mA. Otherwise, GFCI breakers shall be configured for personnel protection with a ground fault trip threshold of 5 mA.

2-8.03. Buses. The panel shall have main and neutral buses insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2-9. POWER PANELS. Unless otherwise specified, each power panel, without a neutral, shall be dead-front, 3 phase panelboard with circuit breakers, in accordance with the Drawings and the following:

2-9.01. Cabinet. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed minimum of NEMA Type 12. Where the indoor area rating is identified as Area Type 4, the enclosure shall be rated NEMA 4X Type 316 stainless steel and if the panel cabinet rating cannot be obtained in NEMA 4X stainless steel, then the panel shall be mounted within an outer, larger NEMA 4X enclosure.

The enclosure shall have a hinged door with latch and lock as well as a hinged trim cover arranged as a door-in-door configuration. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

2-9.02. Circuit Breakers. Circuit breakers shall be thermal-magnetic, inverse time, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip type. Breakers up to 240 volts shall have interrupting ratings not less than 10,000 amperes. Breakers for 277 volts shall have interrupting ratings not less than 14,000 amperes. Breakers for 480 volts shall be rated 600 volts, with interrupting ratings not less than 25,000 amperes for breakers in PP-H4, breakers in PP-TPS shall have interrupting ratings not less than 35,000 amperes at 480 volts.

Inverse-time trip breakers shall be Eaton/Cutler-Hammer Seltronic Circuit Breakers, Square D, Type ME or PE Circuit Breakers, or equal.

Provide solid state trip circuit breakers with an adjustable short-time function, unless another type breaker is required for coordination, or otherwise indicated on the Drawings, for three-pole, 480V feeder circuit breakers with not more than one downstream, 480V, overcurrent protective device, excluding protective devices provided as part of a process equipment package.

Each solid-state trip circuit breakers shall be furnished with at least the following adjustment: long time pickup, long time delay, short time pickup, short time delay, I-squared t, for circuit breakers not covered by either of the above cases. Such breakers shall be General Electrical Circuit Breakers with Microversatrip; Eaton/Cutler-Hammer circuit breakers with Digitrip; or equal.

Handle clips to prevent casual operation of breakers shall be provided for 10 percent at least two of the breakers and applied to the circuits directed.

2-9.03. Buses. The panel shall have 3 phase buses and a ground bus. Buses shall be copper, with ampere and voltage ratings and main lugs or breakers as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2-10. SURGE PROTECTIVE DEVICES.

Each SPD shall be furnished and installed for the electrical equipment indicated on the Drawings or as specified herein. All new lighting and power panels shall be furnished with an integral SPD.

Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

Power panels shall have SPD's rated for a medium-high exposure levels.

The table below lists the specific SPD ratings for new power panels.

Power Panel Name	Location	Voltage/ Phase	Exposure Level
PP-TPS	ICWRC Electrical Building	480V	Medium-high
PP-H4	SRWRC Chemical Building	480V	Medium-high

2-10.02. Standards. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41 and C62.45;

ANSI/IEEE C62.1 and C62.11;

IEEE C62.62;

National Electrical Manufacturers Association NEMA LS1 Guidelines;

National Fire Protection Association NFPA 20, 70 NEC, 75, and 780;

Underwriters Laboratories UL 1449 Third Edition and 1283

The unit shall be UL 1449 Third Edition Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference EMI Filter.

2-10.03. Environmental Requirements.

a. Operating Temperature: 0°F to +140°F -18°C to +60°C.

b. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

2-10.04. Electrical Requirements.

a. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.

b. Maximum Continuous Operating Voltage MCOV. The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.

c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.

d. Protection Modes. Four-wire configured systems shall provide, Line-to-Neutral L-N, Line-to-Ground L-G, and Neutral-to-Ground N-G, and Line-to-Line L-L protection. Three-wire configured systems shall provide, Line-to-Line L-L protection and Line-to-Ground L-G protection.

e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and shall be no less than listed in the following table.

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

f. UL 1449 Third Edition Voltage Protection Rating VPR. The maximum VPR per mode for the device inclusive of disconnect shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
120/208 3-phase	800 V	800 V	800 V	1200 V
480 V 3W		1200 V		2000 V

g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220A.

h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.

i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200 kA symmetrical fault current with 600 volts ac applied.

At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.

The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit. When furnished integral to the panelboard, the status indicators shall be viewable when the panelboard door is opened.

2-10.05. Installation. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

2-10.06. Miscellaneous.

a. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL 1449 Third Edition listed as such, and the UL 1449 Third Edition Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.

b. Enclosure. Not used.

c. Dual Form "C" Dry Contacts. Not used.

2-10.08. Acceptable Manufacturers. Integral SPD's shall be manufactured by Eaton, General Electric, or Schneider-Electric. External SPD's shall be manufactured by Eaton, General Electric, Siemens Energy & Automation, Schneider-Electric, or Current Technology. The products of other manufacturers will not be acceptable

2-11. SEPARATELY ENCLOSED MOTOR STARTERS. Separately enclosed motor starters, unless otherwise specified, shall be full voltage, magnetic, non-reversing and NEMA rated; fractional sizes and ratings per IEC recommendations are not acceptable. The starter enclosures shall have NEMA type designations appropriate for the locations where they will be installed minimum of NEMA Type 12. Unless otherwise noted, NEMA Type 4X 316 stainless steel enclosures shall be provided for outdoor locations.

One bimetallic or melting alloy thermal overload relay shall be provided in each phase lead. Each starter shall be provided with an external, manually reset push button for resetting the thermal overload relays.

Each starter shall include auxiliary contacts as required, plus one spare NO and one spare NC contact.

Contractor shall match the sizes of control power transformers, overload devices, heaters, and starters to the equipment furnished, as they may differ from the values indicated on the Drawings. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

All starters shall be provided with control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring. Terminal blocks shall comply with the construction requirements described within the Terminal Junction Boxes paragraph described elsewhere in this section.

Control relays shall comply with the construction requirements described within the Relay Enclosures paragraph described elsewhere in this section.

All push buttons, selector switches, and pilot lights indicated on the schematics to be provided on or in the starter enclosure shall be 30.5 mm heavy-duty, oiltight construction. At a minimum, provide starter and overload relay auxiliary contacts for red RUNNING light, green STOPPED light and amber OVERLOAD light on the enclosure door. Pilot lights shall be push-to-test full voltage type with LED lamps. Push buttons on starters located outdoors shall be provided with protective caps.

Where elapsed time meters are indicated on the drawings, provide synchronous-motor-driven, elapsed time meters, to 99,999.9 hours range, nonreset type, suitable for semiflush, panel mounting. Provide General Electric Type 240, 2-½-inch Big Look unit, Eagle Signal Bulletin 705 unit, or equal.

Acceptable separately enclosed motor starter manufacturers shall be: General Electric, Schneider Electric, Allen Bradley, Siemens, Eaton/Cutler-Hammer, or equal.

2-11.01. Three Phase Starters. Three phase starters shall be circuit breaker combination type consisting of 3 phase, 60 Hz contactors with thermal overloads, a 120 volt field replaceable ac coil, a dry type control power transformer where required, and a circuit breaker disconnect. Control power transformers shall be sized to handle all simultaneous loads. Starters shall be NEMA ICS-2 Type A and at least NEMA Size 1, or shall be sized as indicated on the Drawings.

Circuit breakers shall be 600 volt magnetic motor circuit protectors for motors smaller than 100 horsepower 75 kW and 600 volt thermal-magnetic type for 100 horsepower 75 kW and larger motors. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism.

Magnetic motor circuit protectors shall have only an instantaneous trip element. The breakers shall be used only as part of a listed combination motor starter. Instantaneous only breakers shall be sized with a continuous rating of at least 115 percent of the full-load current of the motor served. The trip setting shall be continuously adjustable from a lowest setting of not more than 700 percent to a highest setting of not less than 1,300 percent of the motor full-load current. Instantaneous only breakers shall be General Electric Mag-Break; Eaton/Cutler-Hammer MCP; Square D Mag-Guard; or equal.

Three phase starters shall be furnished with external manual breaker operating handles and provisions for up to three padlocks. The access door shall be interlocked with the motor circuit protector, so that the door cannot be opened, except by an interlock override, while the breaker is closed.

The complete 3 phase starter shall have an interrupting rating of at least 42,000 amperes at 480 volts.

2-11.02. Single Phase Starters. Single phase starters shall consist of single phase, 60 Hz contactors with thermal overloads and an integral or separately enclosed short-circuit protection device. Starters shall be at least NEMA Size 0, or shall be sized as indicated on the Drawings. Integral short-circuit protection devices for single-phase starters shall be 120/240 volt, magnetic motor circuit protectors.

Separately enclosed short-circuit protection devices for single phase starters shall be molded-case circuit breakers for motor loads 6 amperes and higher and fused switch disconnects for motor loads lower than 6 amperes. Circuit breaker disconnects shall be 120/240 volt, molded-case, thermal-magnetic circuit breakers. Fused switch disconnects shall have quick-make, quick-break mechanisms and 250 volt, dual-element, time-delay fuses.

The short-circuit protection devices shall have external operating handles capable of being padlocked in the open position, and shall have an interrupting rating of at least 10,000 amperes at 240 volts.

2-12. SEPARATELY ENCLOSED MANUAL STARTERS. Separately enclosed manual starters not specified elsewhere shall be provided hereunder. Manual starters shall be provided with thermal overload protection properly sized for the motors served and with a contact and overload in each phase lead. Provide pushbutton operation for integral horsepower sizes, and toggle switch for fractional sizes. Manual starters shall be NEMA ICS-2 and mounted in minimum NEMA Type 12 enclosures unless otherwise noted. Manual starters outdoors or indicated to be weatherproof shall have NEMA Type 4X 316 stainless steel enclosures.

2-13. CONTROL STATIONS. Control stations shall be provided as indicated on the one-line diagrams or schematics or as required by the equipment furnished. Pilot devices shall meet the requirements of NEMA ICS 2, shall be 30.5 mm heavy-duty, oiltight construction, and shall perform the functions indicated. Contacts shall have NEMA designation rating A600.

Pilot lights shall be push-to-test full voltage type with LED lamps. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

Indoor control stations shall have NEMA Type 13 enclosures such as General Electric Type CR 104P, or equivalent by Square D, Cutler-Hammer, or equal.

Control stations outdoors or indicated to be weatherproof shall have NEMA Type 4X 316 stainless steel enclosures with protective caps on the control devices. Provide special gasketing as required to make complete control station watertight and shall be Square D Type SK, General Electric, Cutler-Hammer, or equal.

Control stations in NEC Class I, Division 1 and Division 2, Group D hazardous areas shall have NEMA Type 7 enclosures, or be factory sealed type, Appleton “Contender Series” or Killark “Seal-X Series”.

2-13.01. Emergency Break-Glass Switch. Each break-glass switch for HVAC emergency shutoff shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Cutler-Hammer "10250TGS" or Square D "Type 9001K15" with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

2-14. SEPARATELY ENCLOSED CIRCUIT BREAKERS. Not used.

2-15. DISCONNECT SWITCHES. Unless otherwise specified, each disconnect switch shall be 3 pole, non-fusible, 600 volts, with a continuous current rating as indicated on the Drawings.

Switches located indoors shall have NEMA type enclosure designations as required by the locations where they will be installed minimum of NEMA Type 12. Switches located outdoors shall have NEMA Type 4X 304 stainless steel enclosures. Switches in chlorine rooms, or in other areas where contact with caustic substances may occur, shall have NEMA Type 4X enclosures of molded reinforced polyester.

Switches shall have high conductivity copper, visible blades; nonteasible, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base. Each switch shall have a handle whose position

is easily recognizable and which can be locked in the "Off" position with three padlocks. The "On" and "Off" positions shall be clearly marked.

All switches shall be UL listed and horsepower kilowatt rated, and shall meet the latest edition of NEMA KS1. Switches shall have defeatable door interlocks that prevent the door from being opened while the operating handle is in the "On" position.

2-16. LIGHTING AND AUXILIARY POWER TRANSFORMERS. Separately mounted transformers shall be provided in the phases, kVA, and voltages indicated on the Drawings. Transformers shall be self-air-cooled, dry type, wall- or floor-mounted, and enclosed for wiring in conduit. Transformers installed outdoors shall be weatherproof. Transformers shall have at least four full capacity voltage taps, two above and two below rated voltage. Transformers shall meet DOE 10 CFR 431 guidelines for energy efficiency.

2-17. POWER CENTERS. Power centers shall consist of a primary breaker, a 480-120/240 volt or 480-120/208 volt transformer, a secondary breaker, and a distribution panelboard in a NEMA Type 3R enclosure. Transformer and circuit breaker configuration and ratings shall be as indicated on the Drawings.

2-17.01. Transformers. Transformers shall be self-air-cooled, dry type. Transformers shall have at least two full capacity voltage taps.

2-17.02. Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers and provisions for future breakers shall be provided in the quantities, poles, and ampere ratings indicated on the Drawings. Breakers shall be single pole, 20 amperes, except as indicated otherwise.

2-18. POWER FACTOR CORRECTION CAPACITORS. Not used.

2-19. LIGHTING CONTACTORS. Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 20 amperes, 600 volts ac, for all types of loads. Terminals shall accept 18 through 10 AWG conductors. Contactors shall operate in any position and may be manually operated for testing and maintenance. Contactors shall be ASCO 918. Contactor control panels shall be UL 508A listed. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

2-20. PHOTOELECTRIC CONTROLS. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary

brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c 11 lux turn-on to 15 ft/c 161 lux turn-off.

2-21. RELAY ENCLOSURES. Relay enclosures shall be furnished as indicated on the Drawings. The enclosure shall have a NEMA designation appropriate for the location where it will be installed minimum of NEMA Type 12. Pilot devices shall be heavy duty, oiltight construction.

Magnetic control relays shall be NEMA Class A600 600 volts, 10 amps continuous, 7,200VA make, 720VA break, industrial control type with field convertible contacts, and meeting the requirements of NEMA ICS 2. Provide General Electric Type CR120B, Cutler-Hammer Type M-600, or equal.

Where time delay relays are specified or indicated on the drawings, unless otherwise noted, provide magnetic control relays with a timer attachment adjustable from 0.2 to 60 seconds minimum and field convertible from ON delay to OFF delay and vice-versa.

Where latching mechanically held relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts. Utilize an attachment allowing 01 easy manual latching and unlatching.

Intrinsically safe relays shall be installed within the enclosures in accordance with NEC requirements and shall be Gems "Safe-Pak", B/W "Series 53", or equal.

2-22. ALARM HORN AND BEACON. Not used.

2-23. HEAT-TRACED PIPING. Outdoor exposed piping shall be heat-traced as indicated on the Drawings and as described herein. Heat tracing shall be sized to maintain pipe temperatures at 40°F with an outdoor ambient temperature of -20°F. Heat tracing shall be of the self-regulating type and shall be suitable for single-phase, 120 volt service. Each run of heat tracing tape shall be provided with a circuit controller, an end-of-line indicating light, junction boxes, mounting accessories, insulation and all other equipment for a complete, properly operating system. Hazardous areas, as indicated on the Drawings and Specifications, shall have heat tracing and associated accessories that are rated for the location. The insulation for all heat tracing shall be as specified in Mechanical Insulation section. Each heat-tracing circuit shall be provided with a microprocessor-based circuit controller to monitor temperature and ground fault current. The controller shall be Chromalox “IntelliTrace Controls Series”, Nelson “CM Series”, Thermon “TC Series”, Raychem "DigiTrace 910", or equal. On all plastic pipe equipped with heat tracing, a layer of conducting tape shall be installed on the pipe before heating cable installation and then again following installation of the heating cable.

PART 3 - EXECUTION

3-1. INSTALLATION, TESTING, AND COMMISSIONING. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

3-2. ARC FLASH HAZARD ANALYSIS. Contractor shall commission an Arc Flash Hazard Analysis for each piece of electrical equipment including lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter sockets, medium-voltage transformers, and other electrical equipment likely to be worked on energized, in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584 and shall submit an Arc Flash Hazard Analysis report as specified herein.

The scope of the analysis shall include all electrical equipment downstream of transformer TX-TP1 & TX-TP2 at Intrenchment Creek WRC and SB-2A & SB-2B at South River WRC**.** The maximum fault contribution from each transformer shall be considered maximum short circuit based on the submitted impedances of each transformer. The minimum fault contribution shall be 50% of the calculated maximum Equipment below 240 volts need not be considered unless it involves at least one 125KVA or larger transformer in its immediate power supply.

The Arc Flash Hazard Analysis shall be performed in association with, or as a continuation of, the short circuit study and protective device study.

Protective-device settings shall be selected to providing the necessary equipment protection and device coordination required while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

The Arc Flash Hazard Analysis shall calculate the arc flash protection boundary and the arc flash incident energy at defined working distances for the locations specified in the analysis. The analysis shall be performed for multiple electrical system modes of operation in order to calculate the worst-case incident energy at each piece of equipment. At a minimum, the system shall be analyzed for the minimum and maximum available fault current and X/R ratios from the electric utility supplying service or for the separately derived power system.

For equipment with an integral main overcurrent protective device that is not adequately isolated from the bus, the upstream protective device shall be used as the fault clearing device in the analysis. Where arc reduction maintenance mode switches are installed on protective devices, the arc reduction shall only apply for downstream equipment that is adequately isolated from the protective device. Adequately isolated equipment shall be confirmed by the equipment manufacturer and shall be submitted to Engineer for review.

The Contractor shall be responsible for collecting all field data for a complete analysis. Assumptions should only be made after every effort has been made to obtain the needed information. All assumptions used in the analysis shall be documented in the report for review by Engineer.

The results shall include, but shall not be limited to, a tabulated spreadsheet of the following items for each piece of equipment included in the analysis:

Equipment name.

Three-phase bolted fault current.

Arcing fault current.

Arcing fault current through the protective device.

Protective device clearing the fault.

Protective device opening time.

Bus gap.

Worst-case incident energy and corresponding working distance. Equipment with arc reduction maintenance mode switches shall include the calculated incident energy level with and without the switch enabled.

Arc flash protection boundary.

An Engineering and Testing Services firm acceptable to Engineer shall conduct the Arc Flash Hazard Analysis.

3-2.01. Arc Flash Analysis Software. The Arc Flash Hazard Analysis shall be performed using the latest version of ETAP electrical power system analysis software, without exception. After the final version of the study and analysis are completed and accepted, Contractor shall provide two 2 copies of the ETAP electronic model file to Owner.

3-2.02. Arc Flash Hazard Report.

Contractor shall be responsible for submitting complete and accurate arc flash analysis information in the Arc Flash Hazard Report. The report shall be submitted to Engineer for review before the final report is prepared. Contractor shall ensure that calculated values for arc flash-protection boundary, working distance, incident energy, and required Personal Protective Equipment is submitted and provide substantiation that the information will be prominently displayed on electrical equipment.

The report shall include the following information at a minimum:

Executive summary.

Description of scope and study methodology.

Documentation of the modes of operation evaluated in the analysis including applicable input data such as utility fault current values.

Discussion of results and any recommendations.

Tabulated results spreadsheet.

List of assumptions.

One-line diagrams from the computer model software showing equipment names and other applicable information.

Documentation of software study parameters and configuration settings.

Recommended arc flash Personal Protective Equipment PPE selection in accordance with NFPA 70E.

The Arc Flash Hazard Analysis report shall be bound in a standard 8-1/2 by 11 inch three-ring binder and shall be submitted in accordance with the Submittals Procedures section. Final selection of required Personal Protective Equipment shall be subject to review and acceptance by Engineer.

The final report shall be signed and sealed by a registered Professional Engineer.

3-2.03. Arc Flash Labeling. After approval of the Arc Flash Hazard Report, Contractor shall furnish and install arc flash labels on the applicable electrical equipment. The arc flash labels shall comply with ANSI Z535.4 and NFPA 70E requirements. Labels shall include, at a minimum, the nominal system voltage, the arc flash boundary distance, worst-case incident energy and the corresponding working distance, date of the analysis, and equipment name.

Equipment with arc reduction maintenance mode switches shall include a dual label with the worst-case calculated incident energy level with and without the switch enabled. The label shall clearly identify the associated maintenance mode switch that shall be enabled in order for the lower incident energy level to apply.

3-3. PROTECTIVE DEVICE STUDY. Contractor shall commission a short circuit study and protective device study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination and protective device settings report as specified herein. The study shall be in compliance with IEEE 242 and include the entire distribution system, including any and all existing power distribution components which will impact the results of the protective device study, starting with the smallest – 480 volt, 3 phase, 60 Hz – circuit protective device on the load end, to the nearest protective device on the power company's line side. Where existing electrical distribution system components are part of the study, the Contractor shall field verify and report the respective ratings and settings of each device as found as a prerequisite to the study analysis being performed. Protective device settings shall be selected to provide selective coordination to the maximum extent possible for equipment protection and device coordination while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

Contractor shall be responsible for and shall ensure that all relays, protective devices and circuit breakers shown on the Drawings and Specifications are sized and set according to the study results.

The study shall include, but shall not be limited to, the following:

Color-coded printouts of coordination curves prepared with calculation software.

A tabulation of all protective relay and circuit breaker trip settings and recommended sizes and types of medium-voltage fuses.

Motor starting profiles for all 50 horsepower 37 kW and larger motors.

Transformer damage curves and protection, evaluated in accordance with IEEE C57.109.

Generator damage curves and protection, evaluated in accordance with manufacturers recommendations.

Coordination curves from the power company, if available.

Calculated short-circuit values at all nodes in the distribution system included within the scope of the protective device study.

Protective device settings shall include, but not limited to, motor and pump RTD settings, motor starts per hour, bus and transformer differential settings, synch-check settings, under and over-voltage settings, under and over-frequency settings, low-voltage breaker and MCC starter overload settings, and all protective functions shown on the Drawings and Specifications

Adjustable frequency drive settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements

Reduced voltage starter settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements

An Engineering and Testing Services firm acceptable to Engineer shall conduct the protective device study.

Contractor shall be responsible for obtaining the following:

The coordination curves for relays, fuses, and circuit breakers.

Transformer damage curves.

Motor and pump data.

Generator data

Other applicable information for all new and existing electrical equipment.

Contractor shall coordinate with the power company to obtain the required protective device curves and shall be responsible for all the field work associated with obtaining the necessary data on existing relays, circuit breakers, fuses, and transformers to be included in the protective device study.

The available 3 phase, symmetrical fault current at the point of service shall be obtained from the Power Company.

The protective device report shall be bound in a standard 8-1/2 by 11 inch 210 by 275 mm three-ring binder and shall be submitted in accordance with the Submittals Procedures section. Final selection of all protective device settings or sizes shall be subject to review and acceptance by Engineer.

3-4. POWER AND SERVICE ENTRANCE INSTALLATION. Not used.

3-5. TELEPHONE SERVICE ENTRANCE INSTALLATION. Not used.

3-6. CABLE INSTALLATION.

3-6.01. General. Except as otherwise specified or indicated on the Drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits as indicated on the one-line diagrams shall be installed continuous and may not be spliced unless approved by the Engineer, or as indicated on the drawings.

a. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.

b. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may be used for splicing solid cable and for terminations at lighting fixtures.

c. Splices may be made only at readily accessible locations.

d. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.

e. All 5,000 volt rated cable and above shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be tape or molded rubber type as required. Shielded cable splices and stress cone terminations shall be made by qualified splicers. Materials shall be by 3M Company, Plymouth/Bishop, or Raychem Electric Power Products.

f. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.

g. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J".

h. Cables operating at more than 2000 volts shall be fireproofed in all cable vaults, manholes, and handholes. Fireproofing shall be applied with a half-lapped layer of 3M "Scotch 77 Arc-Proofing Tape", anchored at each end with a double wrap of 3M "Scotch 69 Glass Cloth Tape" or with equivalent tape by Anixter or Plymouth/Bishop.

i. Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.

j. Spare cable ends shall be taped, coiled, and identified.

k. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.

l. All cables in one conduit, over 1 foot 305 mm long, or with any bends, shall be pulled in or out simultaneously.

m. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.

n. Cables operating at more than 2,000 volts which terminate at medium-voltage padmounted equipment bushings shall include a metal oxide varistor surge protective elbow terminator conforming to IEEE Standard 386. Elbows shall provide a weatherproof, dead-front, hot-stick operable separable connection. Surge protector rating shall be as recommended by the terminator supplier.

o. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.

3-6.02. Underground Cable Pulling Procedure. Not used.

3-6.03. Medium-Voltage Cable Insulation Test. New conductors with insulation rated 5,000 volts and higher shall be given a field dc insulation test.

The ampacity rating of direct current testing equipment shall be at least 2,500 microamperes.

Final test voltages and the duration of the test shall be as indicated on the Cable Data Sheets attached to this section. Cable insulation testing shall be recorded on the Cable Test Data Form attached to this section, Figure 16-16050.

Test procedures shall conform to ICEA S-93-639 NEMA WC 74, 5-46 kV Shielded Power Cable For Use In The Transmission & Distribution of Electric Energy, and the applicable qualification testing standards of AEIC CS-8.

The tests shall be performed by qualified and experienced personnel specializing in electrical cable testing. Triplicate copies of test data for each cable shall be submitted to Engineer.

3-7. RACEWAY INSTALLATION. Contractor shall be responsible for routing all raceway. This shall include all conduits indicated on the one-lines, riser diagrams, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these

Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.

Supports shall not be fastened to piping, ductwork, mechanical equipment, or conduit nor shall structural steel members be drilled for fastening or attaching of equipment or mounting hardware. Powder actuated fastening devices shall not be used.

Except as otherwise specified or indicated on the Drawings, conduit installation and identification shall be completed according to the following procedures.

3-7.01. Installation of Interior and Exposed Exterior Conduit. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified or indicated on the Drawings. No conduit shall be exposed in water chambers unless so indicated on the Drawings.

Unless otherwise indicated on the Drawings, Contractor shall be responsible for routing the conduit to meet the following installation requirements:

a. Conduit installed in all exposed indoor locations, except corrosive areas indicated on the Drawings, and in floor slabs, walls, and ceilings of hazardous classified locations, shall be rigid steel. Exposed conduit shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

b. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 40 PVC.

c. Conduit installed in all exposed outdoor locations shall be galvanized rigid conduit, rigidly supported by galvanized framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

d. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquidtight flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet 1.8 m unless otherwise acceptable to Engineer.

e. Terminations and connections of rigid steel conduit shall be taper threaded. Conduits shall be reamed free of burrs and shall be terminated with conduit bushings.

f. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

g. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.

h. Conduits shall be at least 6 inches 150 mm from high temperature piping, ducts, and flues.

i. Conduit installed in corrosive chemical feed and storage areas as indicated by Area Type on the Drawings shall be rigid Schedule 80 PVC. Exposed conduit in corrosive areas shall be supported by FRP framing materials with stainless steel hardware, including nuts and bolts.

j. Rigid Schedule 40 PVC conduit shall have supports and provisions for expansion as required by NEC Article 352.

k. Metallic conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.

l. Rigid Schedule 40 PVC conduit shall be secured to sheet metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.

m. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.

n. Conduits that cross structural joints where structural movement is allowed shall be fitted with concretetight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 40 PVC conduits. The couplings shall be Appleton Type DF, Crouse-Hinds Type XD, or O-Z Type DX.

o. Conduit shall be clear of structural openings and indicated future openings.

p. Conduits through roofs or metal walls shall be flashed and sealed watertight.

q. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of fire rated structure elements shall be sealed in a manner that maintains the fire rating as indicated on the Architectural Drawings.

r. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

s. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.

t. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.

u. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

v. Horizontal conduit shall be installed to allow at least 7 feet 2.1 m of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.

w. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Engineer.

x. PVC-coated rigid steel conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.

y. All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.

z. Nonmetallic conduit, which turns out of concrete slabs or walls, shall be connected to a 90 degree elbow of PVC-coated rigid steel conduit before it emerges. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.

aa. Power conductors to and from adjustable frequency drives shall be installed in steel conduit where 3-conductor shielded adjustable frequency drive cable is not used.

3-7.02. Underground Conduit Installation. All excavation, backfilling, and concrete work shall conform to the respective sections of these Specifications. Underground conduit shall conform to the following requirements:

a. All underground conduits shall be concrete encased unless indicated otherwise on the Drawings. Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations shall

be reinforced as detailed on the Drawings.

b. Concrete encased conduit shall be PVC utility duct. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from walls and the coupling shall extend 2 inches from the wall. All PVC joints shall be solvent welded in accordance with the recommendations of the manufacturer.

c. Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches 150 mm above grade, with top crowned and edges chamfered.

d. Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug. The termination of the duct bank shall be reinforced with bars 100 diameters long that shall be terminated 2 inches 50 mm from the bulkhead. Matching splice bars shall be 50 bar diameters long. Each longitudinal bar shall be provided with a Lenton "Form Saver" coupler and plate or a Dayton "Superior DBR" coupler at the bulkhead. The coupler shall be threaded to accept a dowel of like diameter in the future. Threads shall be protected with screw-in plastic caps. A 1-3/4 by 3/4 inch 45 by 20 mm deep horizontal shear key shall be formed in the concrete encasement above and below the embedded conduits. After concrete placement, conduit and bar connector ends shall be cleaned and coated with two coats of thixotropic coal tar.

e. Underground conduits indicated not to be concrete encased shall be rigid Schedule 40 PVC.

f. Underground conduit bend radius shall be at least 2 feet 600 mm at vertical risers and at least 3 feet 900 mm elsewhere.

g. Underground conduits and conduit banks shall have at least 2 feet 600 mm of earth cover, except where indicated otherwise and shall include burial locating wire installed above the duct bank. In addition, a red dusting will be added to the top of all concrete encased duct banks.

h. Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in the Cast-In-Place Concrete section.

i. Underground nonmetallic conduits, which turn out of concrete or earth in outdoor locations, shall be connected to 90 degree

elbows of PVC-coated rigid steel conduit before they emerge.

j. Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

k. Underground conduits shall be sloped to drain from buildings to manholes.

l. Each 5 kV or higher voltage cable, each 250 kcmil 120 mm2 or larger cable, and each conduit group of smaller cables shall be supported from manhole walls by Kindorf "D-990" or Unistrut "P-3259" inserts, with Kindorf "F-721-24" or Unistrut "P-2544" brackets and Unistrut "P1753" or "P1754" fiberglass reinforced polyester cable saddles.

m. Telephone, fiberoptic and LAN/Data Highway network communications cables shall not be installed in raceways, conduits, boxes, manholes, or handholes containing other types of circuits.

n. Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.

3-7.03. Sealing of Conduits. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch 25 mm and larger conduit connections to equipment.

Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.

Conduits running between conditioned and non-conditioned spaces, such as between electrical/control rooms and process rooms shall be sealed to prevent the intrusion of moisture.

Conduits entering hazardous classified areas and submersible or explosion proof enclosures shall have Appleton "Type ESU" or Crouse-Hinds "EYS" sealing fittings with sealing compound.

3-7.04. Reuse of Existing Conduits. Existing conduits may be reused subject to the concurrence of Engineer and compliance with the following requirements:

a. A wire brush shall be pulled through the conduit to remove any loose debris.

b. A mandrel shall be pulled through the conduit to remove sharp edges and burrs.

3-8. WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION. Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

3-8.01. Conduit Boxes and Fittings.

a. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.

b. Galvanized or cadmium plated sheet steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.

c. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

d. PVC coated boxes and fittings shall be installed in PVC coated conduit systems.

e. Telephone fiberoptic and LAN/Data Highway network communications conduit shall be provided with separate junction boxes and pull fittings.

3-8.02. Device Plates. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

3-8.03. Wall Switches.

a. Wall switches shall be mounted 3'-6" 1.05 m above floor or grade.

b. After circuits are energized, all wall switches shall be tested for proper operation.

3-8.04. Receptacles.

a. Convenience outlets shall be 18 inches 450 mm above the floor unless otherwise required.

b. Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet 1.2 m above floor or grade.

c. Welding receptacles shall be surface-mounted 4 feet 1.2 m above the floor.

d. After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.

e. Conduit and wire for convenience outlet installation is not shown on the Drawings and shall be sized, furnished, and installed by Contractor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for convenience outlet installation.

3-8.05. Special Outlets.

a. Wall thermostats shall be 4'-6" 1.35 m above the floor unless otherwise required. Thermostats on exterior walls shall be suitably insulated from wall temperature.

b. Telephone outlets shall be 18 inches 450 mm above the floor unless otherwise required. Telephone outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet 1.2 m above floor or grade.

c. Horns and strobe lights for audio/visual alarms shall be mounted a minimum of 8 feet above finished floor and shall be positioned to provide maximum penetration of the surrounding area.

3-9. EQUIPMENT INSTALLATION. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.

3-9.01. Setting of Equipment. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/2 inch 12 mm thick corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.

3-9.02. Sealing of Equipment. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795" or General Electric "SCS1200".

3-9.03. Fuse Installation. The Contractor is responsible to furnish all fusible devices with fuses and for any required replacement of blown fuses up to Final Completion of the Project. Upon Final Completion of the Project, turn over to the Owner spare fuses for each type and size installed; six each for ratings 60 amps and below, and three each for ratings above 60 amps.

3-10. GROUNDING.

3-10.01. General. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:

a. All ground conductors shall be at least 12 AWG 4 mm^2 soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.

b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections, Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with high-compression two-hole lugs.

c. Ground cable through exterior building walls shall enter within 3 feet 900 mm below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch 300 mm copper disc over the cable.

d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches 600 mm. The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches 750 mm below grade, or below the frost line, whichever is deeper.

e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.

f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.

g. The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches 300 mm.

i. Ground rods not described elsewhere shall be a minimum of 3/4 inch 19 mm in diameter by 10 feet 3 m long, with a copper jacket bonded to a steel core.

j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

3-10.02. Grounding System Resistance. The ground system resistance shall comply with National Electrical Code.The grounding system design depicted on the Contract Drawings is the minimum design required for each building or structure. Each system shall comply with the maximum resistance of 5 ohms to ground. Contractor shall confirm the system grounding resistance with the results of the testing specified herein. Systems exceeding the maximum resistance specified shall be supplemented with additional grounding provisions and retested until the maximum specified resistance is achieved.

3-10.03. Grounding System Testing. The grounding system of each new building or structure and each existing building or structure indicated below, shall be tested to determine the resistance to earth. Testing shall be performed by an independent electrical or grounding system testing organization. Testing shall be completed after not less than three full days without precipitation and without any other moistening or chemical treatment of the soil.

3-10.03.01. New Grounding Systems. Grounding systems of each new building or structure shall be tested for resistance to earth utilizing the three-point fall of potential test as defined by IEEE 81. Testing shall be completed prior to installation of the electrical distribution equipment to ensure the grounding system is isolated from the utility grounding system and the systems of other structures. The current source probe for the test shall be placed in soil at a distance of 5 to 10 times the distance of the widest measurement across the grounding system ring or grid to ensure adequate measurements outside of the grounding system's sphere of influence. Test probe measurements shall be taken at a distance of one foot from the grounding system reference connection and at each 10 percent increment from the grounding system reference connection to the current source probe location. Test results shall be documented on a graphical plot with resistance in ohms on the vertical axis and distance in feet on the horizontal axis. The results shall clearly indicate a system resistance plateau which confirms a valid test procedure.

3.10.03.02. Existing Grounding Systems. Grounding systems of each existing building or structure indicated shall be tested for resistance to earth.

Existing building(s) or structure(s) to be tested	SRWRC – Existing Chemical Building SRWRC – North Primary Sludge Pump Station ICWRC – Headworks Facility ICWRC – Power Generation Facility ICWRC – Existing EQ Tank No.1 ICWRC – Existing EQ Tank No.2

Where existing grounding systems can be isolated from the building power service or utility power service a three-point fall of potential test shall be completed as indicated above. Where isolation of the building grounding system is not practical, a clamp-on resistance test will be an acceptable alternative. Clamp-on resistance testing shall be completed utilizing a ground resistance tester specifically designed for clamp on resistance testing, such as the AEMC "Model 3711". Clamp-on resistance measurements shall be taken at the service side of the service entrance neutral, upstream of the neutral to ground bonding connection to ensure a single path between the grounding system and the utility reference.

3.10.03.03. Grounding System Test Report. A report certified by the testing organization shall be prepared and submitted in accordance with the Submittals

Procedures section. The final report shall include complete testing results for each building or structure, graphical representation of the test point results for the three-point fall of potential method, and complete observations of all site weather conditions and other environmental conditions that may affect the test results. Final acceptance of the results reported shall be subject to the review and approval of Engineer.

3-11. LIGHTING FIXTURE INSTALLATION. The Drawings indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.

Conduit and wire for lighting fixture installation is not shown on the Drawings and shall be sized, furnished and installed by Contractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to fluorescent lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for lighting fixture installation.

3-12. POWER FACTOR CORRECTION CAPACITOR INSTALLATION. Not used.

3-13. HEAT-TRACED PIPING INSTALLATION. Factory inspections and tests for heat tracing cables shall include but are not limited to the following:

a. Testing shall be done in accordance with IEEE 515 test section and applicable manufacturer's standards.

b. Megger test of heater cables shall be at jobsite when received before installation.

c. Megger test of heater cables shall be performed after installation, but before insulation is applied.

d. Megger test of heater cables shall be performed after insulation has been installed.

e. All three of the above field megger readings shall be greater than 20 megohms. If any heater cable does not pass the megger test it shall be replaced at the Contractors expense.

f. Field megger tests shall be recorded for each heater cable, and certified reports shall be submitted to the Engineer.

3-14. MODIFICATIONS TO EXISTING EQUIPMENT. Modifications to existing equipment shall be completed as specified herein and indicated on the Drawings. All existing facilities shall be kept in service during construction. Temporary power or

relocation of existing power and control wiring, equipment, and devices shall be provided as required during construction. Coordination and timing of outages shall be as specified in other sections of these Specifications. Electrical power interruptions will only be allowed where agreed upon in advance with Owner, and scheduling at times of low demand may be required.

3-14.01. MODIFICATIONS TO SWGR #1 AND SWGR #4 RELAYS. Existing SWGR #4 is a GE PowerVac Switchgear with GE overcurrent relays. SWGR #1 is a GE PowerVac Switchgear with GE overcurrent relays. Settings of the relays shall be adjusted in accordance with the power system study.

3-14.02. Demolition. Unless otherwise specified or indicated on the Drawings, all cable and all exposed conduit for power and control signals of equipment indicated to be removed shall be demolished. Conduit supports and electrical equipment mounting hardware shall be removed, and holes or damage remaining shall be grouted or sealed flush. Conduit partially concealed shall be removed where exposed, and plugged with expanding grout flush with the floor or wall. Repairs shall be refinished to match the existing surrounding surfaces. Demolished equipment shall be discarded or salvaged as indicated on the Drawings and as specified in other sections of these Specifications.

End of Section

STANDARD SPECIFICATIONS

REFERENCE: ICEA S-95-658 NEMA WC 70.

CONDUCTOR: Concentric-lay, uncoated copper; strand Class B. Wet/dry maximum operating temperature 90°C.

INSULATION: Cross-linked thermosetting polyethylene, ICEA S-95-658, Paragraph 3.6.

SHIELD: None.

JACKET: None.

FACTORY TESTS: Cable shall meet the requirements of ICEA S-95-658.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	μm	in.	mm
14	2.5	7	0.030	760	0.17	4.32
12	4.0	7	0.030	760	0.19	4.83
10	6.0	7	0.030	760	0.21	5.33
8	10.0	7	0.045	1140	0.27	6.86
6	16.0	7	0.045	1140	0.31	7.87
4	25.0	7	0.045	1140	0.36	9.14
2	35.0	7	0.045	1140	0.42	10.67
1	40.0	19	0.055	1400	0.48	12.19
1/0	50.0	19	0.055	1400	0.52	13.21
2/0	70.0	19	0.055	1400	0.57	14.48
4/0	95.0	19	0.055	1400	0.68	17.27
250	120.0	37	0.065	1650	0.75	19.05
350	185.0	37	0.065	1650	0.85	21.59
500	300.0	37	0.065	1650	0.98	24.89
750	400.0	61	0.080	2030	1.22	31.00
1,000	500.0	61	0.080	2030	1.37	34.80

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches 600 mm. Marking shall include manufacturer's name, XLP, XHHW-2, conductor size, and voltage class.

600 Volt, Single Conductor Lighting/Power Cable 600-1-XLP-NONE-XHHW-2

BLACK & VEATCH	Cable Data	Figure 2-16050

STANDARD SPECIFICATIONS

REFERENCE: UL 62, UL 1277.

CONDUCTOR: 16 AWG 1.5 mm², 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils 380 μm average thickness; 13 mils 330 μm minimum thickness, UL 62, Type TFN.

LAY: Twisted pair with 1-1/2 inch to 2-1/2 inch 38.10 mm - 63.5 mm lay.

SHIELD: Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG 0.5 mm² minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.

JACKET: Conductor: Nylon, 4 mils 100 μm minimum thickness, UL 62.

Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION: One conductor black, one conductor white.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 62 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		**Maximum Outside Diameter**	
	in.	**μm**	**in.**	**mm**
Single Pair	0.045	1140	0.34	8.64

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches 600 mm. Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single pair, and voltage class.

600 Volt, Single Pair, Shielded Instrument Cable 600-SINGLE-PAIR-SH-INSTR

BLACK & VEATCH	**Cable Data**	**Figure 4-16050**

STANDARD SPECIFICATIONS

REFERENCE: ICEA S-93-639 NEMA WC 74, AEIC CS-8, ICEA P-45-482.

CONDUCTOR: Concentric-lay, uncoated or coated copper, strand Class B. Normal maximum operating temperature 90°C.

CONDUCTOR SHIELD: Extruded semiconducting thermosetting material, ICEA S-93-639, Section 3.

INSULATION: Ethylene-propylene rubber, ICEA S-93-639, Section 4, not less than 115 mils 2920 μm average thickness; 103.5 mils 2630 μm minimum thickness.

INSULATION SHIELD: Extruded semiconducting thermosetting material, and nonembedded coated copper tape or coated copper wires, ICEA S-93-639, Section 5. Extruded material shall be tested in accordance with ICEA S-93-639 and AEIC CS-8. Shield area shall be not less than that of one helically applied 5 mil 130 μm copper tape with a 10 percent overlap when calculated according to Formula 3 in ICEA P-45-482.

JACKET: Black polyvinyl chloride, ICEA S-93-639, Paragraph 7.1.9.

FACTORY TEST: Cable shall meet the requirements of ICEA S-93-639 and AEIC No. CS-8.

Cable Details

Size		Number of Strands	*Jacket Thickness		Maximum Outside Diameter	
AWG or kcmil	mm²		in.	μm	in.	mm
6	16	7	0.060	1520	0.74	18.8
4	25	7	0.060	1520	0.78	19.81
2	35	7	0.060	1520	0.84	21.34
1	40	19	0.060	1520	0.88	22.35
1/0	50	19	0.060	1520	0.92	23.37
2/0	70	19	0.080	2030	1.01	25.65
4/0	95	19	0.080	2030	1.12	28.45
250	120	37	0.080	2030	1.18	29.97
350	185	37	0.080	2030	1.29	32.77
500	300	37	0.080	2030	1.45	36.88
750	400	61	0.080	2030	1.65	41.91
1000	500	61	0.080	2030	1.81	45.97

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above.

The conductor shield, insulation, and insulation shield shall be applied in a triple extrusion process with all three components being cured at the same time.

The color of the insulation shall be in contrast to the color of the semiconducting paint. The semiconducting paint shall be readily removable for terminating.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches 600 mm. Marking shall include manufacturer's name, insulating material, conductor size, and voltage class.

Voltage Test After Installation: DC Test Voltage - 36 kV
Duration of Test - 15 Minutes

8000 Volt, Single Conductor Power Cable
100 Percent Insulation Level 8000-1-EPR-PVC-SH

BLACK & VEATCH	Cable Data	Figure 9-16050

Section 16100

ELECTRICAL EQUIPMENT INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the installation of electrical equipment.

1-2. GENERAL. Equipment specified to be installed under this section shall be erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The electrical equipment identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

1-2.01. Coordination. When manufacturer's field services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 14 days prior to the need for manufacturer's field services furnished by others.

Submittals for equipment furnished under the original procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

1-3. DELIVERY, STORAGE, AND HANDLING.

1-3.01. Delivery. When sills are required for electrical equipment, they shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed.

1-3.02. Storage. Upon delivery, all equipment and materials shall immediately be stored and protected by Contractor in accordance with Product Storage and Handling Requirements section, and in accordance with manufacturer's written instructions, until installed in the Work. Equipment shall be protected by Contractor against damage and exposure from the elements. At no time shall the equipment be stored on earth or grass surfaces or come into contact with earth or grass. Contractor shall keep the equipment clean and dry at all times. Openings shall be plugged or capped (or otherwise sealed by packaging) during temporary storage.

1-3.03. Handling. Electrical equipment shall be moved by lifting, jacking, or skidding on rollers as described in the manufacturer's instructions. Special lifting harness or apparatus shall be used when required. Lifting and jacking points shall be used when identified on the equipment. Contractor shall have required unloading equipment on site to perform unloading work on the date of equipment delivery.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3-1. INSTALLATION, TESTING, AND COMMISSIONING. All installation work shall be in accordance with manufacturer's written instructions.

All material, equipment, and components specified to be installed according to this section shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

Electrical equipment cubicles and vertical sections shall be installed plumb and level. Drawout equipment carriages, circuit breakers, and other removable components shall operate free and easy without binding or distortion.

Unless otherwise indicated or specified, all indoor floor-mounted electrical equipment and control cabinets shall be installed on concrete equipment pads four inches in height.

Indoor metalclad switchgear shall be bolted to steel floor channels which are installed level and flush with the top of the concrete floor or equipment pad.

Outdoor metalclad switchgear and interrupter gear with integral floor channels or beams shall be secured to concrete pads with anchor bolts and clips.

Motor control centers with integral floor sills shall be secured to concrete floors or equipment pads with anchor bolts.

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

3-1.01. Cleaning. All deposits of oil, grease, mud, dirt or debris shall be cleaned from the electrical equipment following installation and field wiring. A detergent water based

solution, or other liquid cleaners not harmful to material or equipment finishes, shall be used as recommended by the manufacturer.

End of Section

Section 16150

ADJUSTABLE FREQUENCY DRIVES

PART 1 - GENERAL

1-1. SCOPE. This section covers pulse width modulated (PWM) type adjustable frequency drives (AFD) for the equipment and locations as specified. AFDs shall meet the design conditions and features specified herein.

Driven equipment Specification number.	11309	11387	11120
Unit designations.	ICWRC Transfer Pumps	SRWRC Sludge Pumps	SRWRC Drain Pumps

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Equipment provided under this section shall be fabricated as specified in this section and as shown on the schematics and one line diagrams on the Drawings.

Unless otherwise indicated on the Drawings, one adjustable frequency drive, complete with all required control components, shall be furnished for each motor.

AFDs shall be designed, manufactured, supplied, and warranted as a complete system by the AFD manufacturer. Fabrication and assembly of the drive system not directly controlled by the AFD manufacturer will not be acceptable.

1-2.01. Coordination. The design of the adjustable frequency drive shall be coordinated with the driven equipment. Contractor shall be responsible for coordinating the collection of data and the design effort to limit harmonics to the levels specified.

The manufacturer of the driven equipment shall be responsible for furnishing the adjustable frequency drive. Contractor shall be responsible for coordinating adjustable frequency drive equipment amongst the driven equipment suppliers to ensure all drives are a product of the same manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1-2.05. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1-2.06. Governing Standards. The adjustable frequency drive shall be designed, constructed, and tested in accordance with the applicable standards of NEMA, ANSI, UL, and IEEE, and shall be designed for installation in accordance with the NFPA 70.

The equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be conducted at Contractor’s expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.

1-2.07. Nameplates. Nameplates with the description and designation of each control or indicating device shall be provided. Unless specified otherwise, each drive enclosure shall be provided with a nameplate bearing the unit designation as indicated above. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch [10 mm] high letters for the drive designation and

3/16 inch [5 mm] letters for other information. The engraving shall extend through the black exterior lamination to the white center.

Each control device and each control wire terminal block connection inside the enclosure shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1-3. DESCRIPTION. The AFD shall produce an adjustable ac voltage/frequency output and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

1-3.01. Six-Pulse Drives. Drives for motors rated below 100 horsepower, shall be of the pulse-width modulated type and shall consist of a full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.

The drive inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by six identical base driver circuits. The drive shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. Drives shall be provided with 5% line reactors.

1-3.02. Eighteen-Pulse Drives and Active Front End Drives. Drives for motors rated 100 horsepower and above, shall be eighteen-pulse or active front end type.

1-3.02.01. Eighteen-Pulse Drives. Eighteen-pulse drives shall be of the pulse-width modulated type and shall consist of an 18-pulse, full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.

The phase shifting transformer required to produce the phase shifted input to the 18-pulse rectifier shall be factory wired and mounted within the drive enclosure as an integral part of the drive assembly. External transformers shall not be required.

The AFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by identical base driver circuits. The AFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1-3.02.02. Active Front End Drives. Active front end drives shall be of the pulse-width modulated type and shall consist of an active front end with insulated gate bipolar

transistors (IGBTs). Incoming power shall be filtered by an integral inductor-capacitor-inductor (LCL) filter. The filter shall filter out the high frequency content of the IGBT front end. The drive shall be able to boost the incoming voltage by 20% and ride through voltage dips of 35%. Power factor shall be adjustable as leading or lagging by up to 20%. The main control board for the IGBT input shall be identical to the main control board for the IGBT output. The drive shall be equipped with an integral input contactor that opens when the drive is not running and closes when a drive run signal is initiated.

The AFD inverter ouput shall be generated by IGBTs which shall be controlled by identical base driver circuits. The AFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1-4. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the drive shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

a. Name of manufacturer.
b. Types and model numbers.
c. Rated drive input kVA and output kVA.
d. Percent efficiency at 100 percent speed and 60 percent speed.
e. Maximum Btu [kJ] heat release data and verification of the drive cooling requirements.
f. Total weight and lifting instructions, height, mounting, and floor space required.
g. Panel interior and front and side exterior view details showing maximum overall dimensions of all transformer, bypass contactor, ac line filter, ac line reactor, and drive compartments.
h. Schematics, including all interlocks.
I. Wiring diagrams, including all internal and external devices and terminal blocks.
j. Locations and sizes of electrical connections, ground terminations, and shielded wires.
k. List of diagnostic indicators.
l. List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.
m. List of standard features and options.
n. List of spare parts to be furnished.
o. Input line protection model numbers and manufacturer's data sheets.
p. Output filter model number and manufacturer's data sheets.

q. UL 508C Certificate of Compliance for short circuit current rating.
r. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
s. Not used.
t. Harmonic calculations by the drive manufacturer at the points of analysis. Detailed drawings and information showing how protection is applied to comply with harmonic limits.

1-5. OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

Operation and maintenance manuals shall include the following:

a. Manufacturer's operation and maintenance manual for each size of adjustable frequency drive.
b. Manufacturer's standard manuals for each size and type of bypass contactor, transformer, line reactor, and filter.
c. Schematics, wiring diagrams, and panel drawings in conformance with construction record.
d. Model numbers and up-to-date cost data for spare parts.
e. Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.
f. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
g. Information on testing of power supplies and printed circuit boards and an explanation of the drive diagnostics.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
1-6. SPARE PARTS. The drive manufacturer shall provide spare parts for each type and size of drive supplied. The spare parts shall include at least one complete set of all plug-in components for each size and type of drive, and shall include the following:

Power fuses

Control fuses

Indicating lights

Rectifier power semiconductors

Inverter power semiconductors

One of each type printed circuit board and gate firing board

Other field-replaceable component parts

Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

1-6. PROTECTIVE DEVICE STUDY. A protective device study of the power distribution system will be conducted as specified in the Electrical section. The equipment manufacturer shall provide the following information to Engineer with the initial equipment drawing submittal:

Protective relay coordination curves for each solid-state trip device.

Time current curves for each circuit breaker.

Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. All drives shall be pulse-width modulated type, as manufactured by ABB, Eaton, Rockwell Automation, Siemens W-Series, Schneider-Electric, or Toshiba without exception. Active front end drives shall be as manufactured by ABB without exception. The products of other manufacturers will not be acceptable.

All adjustable frequency drives shall be a product of the same manufacturer.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS.

2-2.01. Performance. The adjustable frequency drive controller shall be of sufficient capacity and shall produce a quality output waveform for stepless motor control from 10 to 100 percent of base speed. The adjustable frequency drive shall be suitable for loads and shall have voltage ratings as follows:

Unit designations	Transfer Pumps	Sludge Pumps	Drain Pumps
Load type	Variable torque (VT)	Constant torque (CT) (Section 11387)	Constant torque (CT)
Input voltage	480 volt, 3 phase	480 volt, 3 phase	480 volt, 3 phase

The adjustable frequency drive shall be suitable for operation at an elevation below 3300 ft [1000 m], and shall meet the following ratings and parameters:

Input frequency	60 Hz
Input voltage and frequency variation	±10 percent voltage variation, ±2 Hz; imbalance, 2 percent maximum.
	Continued operation with additional momentary 25 percent voltage dip of 0.5 second duration from nominal input voltage level.
Minimum drive efficiency	95 percent at 100 percent speed, 90 percent at 60 percent speed.
Ambient temperature	0 to 40°C.
Relative Humidity	0 to 95 percent non-condensing.
Displacement Power Factor	95 percent or higher throughout the entire operating speed range, measured at drive input terminals.
Drive service factor	1.0.
Overcurrent capability	110 percent for 1 minute for variable torque; 150 percent for 1 minute for constant torque.
Volts/Hz ratio	Voltage varies as the square of frequency over the entire range of the unit for variable torque drives, linear over the entire range of the unit for constant torque drives; except under voltage boost condition.
Acceleration/deceleration time	Adjustable over a range that meets the requirements of the drive equipment.
Output speed regulation	0.5 percent.
Output frequency stability	0.5 percent of nominal.

2-2.02. Adjustments. The following drive adjustments shall be provided:

Maximum speed.

Minimum speed.

Linear acceleration time.

Linear deceleration time.

Volts/Hz ratio; linear, squared, and automatic settings.

Voltage boost.

Process follower gain, offset, and bias.

Torque limit.

Critical frequency avoidance with adjustable bandwidth.

2-2.03. Fault Protection. Design of the power circuit shall include provisions for protection against fault conditions as follows.

2-2.03.01. Input Protection.

The drive assembly shall be UL 508C listed. A UL Certificate of Compliance shall be submitted to confirm product compliance with UL 508C and to indicate the short circuit current rating. The short circuit current rating shall meet or exceed the available short circuit current indicated on the Drawings.

Solid state instantaneous overcurrent trip set at 180 percent.

Adjustable overvoltage and undervoltage protection with automatic restart.

Phase loss and reverse phase trip with manual restart.

2-2.03.02. Internal Protection. AC Line, phase to pahse transient voltage surge suppression utilizing metal oxide varistors. Drive shall meet the requirements of IEEE C62.41 Power device snubbers.

Power devices rated 2.5 times line voltage.

Instantaneous overcurrent.

Static overspeed (overfrequency) protection.

DC bus overvoltage trip.

Components and labeling that comply with UL 508 requirements. Drives shall be equipped with an automatic discharge circuit to deplete the charge on the DC capacitor bank to less than 50 volts within 60 seconds after main input power is removed. Labels indicating derivative voltage sources and required wait time for servicing after power removal shall be placed on all applicable enclosures.

Individual transistor overtemperature and overcurrent protection.

Control logic circuit malfunction indication.

2-2.03.03. Output Protection.

Inverse-time motor overload protection adjustable from 10 percent to 100 percent.

Overvoltage protection.

Overfrequency protection.

Short circuit protection (three phase, phase to phase, and ground fault protection).

Protection against opening or shorting of motor leads.

Static overspeed protection.

Stall protection on overload with inverse time overcurrent trip, adjustable current limit from 10 percent to 120 percent.

2-2.04. Harmonic Distortion Abatement. The electrical system shall be provided with the necessary equipment to protect the drive and the power system ahead of the drive from harmonic distortion, as described below. The harmonic distortion abatement analysis shall be based on the information on the Drawings and on the following:

	ICWRC	SRWRC
Existing facility loads to be included in the analysis	Not applicable	Not applicable
Short circuit current at upstream bus	57,500 amps	20,100 amps
Total maximum running amperes of all equipment powered from the utility connection	3,300 amps	1,100 amps

The drive shall operate satisfactorily when connected to a bus supplying other solid-state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt-microseconds.

Harmonic distortion abatement equipment shall be provided to bring the facility and its electrical system into compliance with IEEE 519, 1992 at the points of analysis defined below and indicated on the Drawings. The supplier shall review the existing facility loads and shall take note of the equipment listed above. All distortion reports and/or testing shall include the existing facility loads. The maximum total harmonic distortion (THD and TDD) allowed at the points of analysis shall include harmonics from the existing equipment as well as the harmonics from equipment provided under this section.

2-2.04.01. Current Distortion Limits. Maximum allowable total and individual harmonic current distortion limits for each odd harmonic shall not exceed limits set forth in IEEE 519, 1992. The upstream bus shall be the primary point of analysis for current distortion. The values of short circuit current at the bus and the total maximum running amperes of all equipment powered from the bus shall be as indicated above.

2-2.04.02. Voltage Distortion Limits. Individual or simultaneous operation of the drives shall result in a maximum total harmonic voltage distortion of 5 percent on the bus feeding the drives. The point(s) of analysis for harmonic voltage distortion testing shall be the nearest electrical bus on the supply side of each drive. The three phase fault current at the bus feeding the drives is as indicated in the above table.

2-3. CONSTRUCTION. Construction requirements shall be as follows and as specified below:

Unit designations	Sludge Pumps	Transfer Pumps	Drain Pumps
Cable entry	Bottom	Bottom	Bottom
Cable exit	Bottom	Bottom	Bottom
Enclosure type	NEMA Type 1	NEMA Type 1	NEMA Type 1

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-3.01. Fabrication and Assembly. The adjustable frequency drive system shall be shop assembled in a single enclosure using interchangeable plug-in printed circuit boards and power conversion components wherever possible. Shop assembly shall be performed by the drive manufacturer, or a manufacturer approved assembly center under the direction and control of the drive manufacturer; systems fabricated, assembled, and supplied in whole or in part by parties other than the drive manufacturer will not be acceptable. Changes to the drive manufacturer's product by a distributor or system integrator are not allowed.

Input line reactors, fuses, circuit breakers, and filters, where required, shall be mounted within the drive enclosure, without exception. Isolation/voltage matching transformers, where required, may be enclosed separately from the remaining drive equipment.

The adjustable frequency drive system shall be designed to fit in the space indicated on the Drawings.

2-3.02. Wiring. Internal cabinet wiring shall be neatly installed in wireways or with wire ties where wireways are not practical. Where wireway is used, they are to be mounted to the panel surface with a continuous run of 3M brand, or equal, industrial two-sided adhesive strip. For 12 AWG wire sizes and smaller, and in bundles of six or less, wire tie-down square mounting straps shall be permitted. Tie-down mounts shall be installed at 8" increments or less. All mounting surfaces shall be pre-cleaned with isopropyl alcohol to ensure proper adhesion over the life of the equipment.

Terminal blocks shall be nonbrittle, interlocking, track-mounted type, complete with a marking strip, covers, and pressure connectors. Screw terminals will not be acceptable. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. In freestanding panels, 8 inches [200 mm] of clearance shall be provided between terminals and the panel base for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Terminals shall be labeled to agree with the identification on the submittal drawings. Each control loop or system shall be individually fused, clearly labeled, and located for ease of maintenance.

All grounding wires shall be attached to the sheet metal enclosure with a ring tongue terminal. The surface of the sheet metal shall be prepared to ensure good conductivity and corrosion protection.

Wires shall not be kinked or spliced and shall be color coded or marked on both ends. The markings or color coding shall agree with the submittal drawings.

With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for at least 600 volts, with a moisture-resistant and flame-retardant covering rated for at least 90°C.

2-3.03. Enclosures. The drive shall consist of factory mounted and wired components within an enclosure, arranged so no electrically live components, terminals, or conductors are accessible on the front panel or door when the enclosure door is open.

The complete drive package, including accessories, shall fit into the space indicated on the Drawings.

Freestanding panels shall be suitable for mounting on a concrete pad and shall include provisions for anchoring to the supporting structure. Suitable lifting facilities shall be provided for handling and shipment.

Relays, terminals, and special devices inside the control enclosure shall have permanent markings to match the identification on the manufacturer's wiring diagrams.

2-3.04. Printed Circuit Boards. All printed circuit boards shall be sprayed on both sides with a conformal coating. The conformal coating shall be a part of the AFD

manufacturing process and shall be selectively applied to the circuit board connections only. Heat sinks and resistors on the circuit board shall not be coated. Conformal coating shall be Konform "C416", HumiSeal, or equal.

All plug-in type boards shall be mechanically held at the circuit board connector. Compression fit only at the connector will not be acceptable.

2-3.05. Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop cleaned in accordance with the coating manufacturer's recommendations, and finished with the drive manufacturer's standard coating. Finish color shall be medium gray.manufacturer's standard color. Dry film thickness of the finish coat shall be at least 4 mils [100 µm]. Field painting, other than touch up, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings. A corrosion resistant coating shall be furnished.

All intermediate and finish coating materials shall be fumeproof and suitable for a wastewater treatment plant atmosphere that contains hydrogen sulfide. Documentation verifying that the coating material is fumeproof shall be submitted. Coatings shall be lead-free and mercury-free.

2-4. OPTIONAL EQUIPMENT.

2-4.01. Bypass Switch. Not used.

2-4.02. AC Line Reactors. Each six-pulse AFD, where isolation/voltage matching transformers are not used, shall be supplied with an input ac line reactor. AC line reactors shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the AFD input power devices. AC line reactors shall be factory mounted and wired within the AFD enclosure. AC line reactors shall be K-rated per IEEE C57-110 and shall be TCI Model KLR, or equal.

2-4.03. Harmonic Filters. When harmonic filters are required to comply with the total harmonic distortion limits specified herein, the AFD manufacturer shall design and provide the required filters. The harmonic filters shall utilize an interlocking contactor that shall be automatically operated by the AFD run circuit. The AFD manufacturer shall be responsible for the complete filter unit, including the filter contactor. Harmonic filters shall be TCI Harmonic Guard HG7 Series, or equal.

2-4.04. Isolation/Voltage Matching Transformers. Not used.

2-4.05. Power Factor Correction Capacitors. Not used.

2-4.06. Output dV/dt Filters. Output filters shall be installed inside the drive enclosure on the inverter output. Output filters shall consist of a minimum 1.5 percent impedance reactor, in conjunction with a resistor and capacitor network, to form a damped low-pass filter. Use of output reactors alone is not acceptable. Output filters shall be TCI Model V1000 KLC, or equal.

2-5. CONTROLS.

2-5.01. Features. Each drive shall include the following features in addition to those indicated on the Drawings:

a. A door mounted membrane keypad with integral two-line, 24 character minimum LCD display that is capable of controlling the AFD and setting drive parameters. The keypad module shall be programmed with factory set drive parameters in nonvolatile EEPROM or FLASH memory and shall be resettable in the field through the keypad.
b. Control switches and pilot lights shall be provided as indicated on the schematic diagrams. Manual-automatic and start-stop controls included as features of the drive keypad shall be password protected or disabled to prevent override of control switches and safety interlocks shown on the schematic diagrams.
c. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.
d. Microprocessor-based regulator. Nonvolatile memory modules shall have a useful life of at least 20 years without requiring battery or module replacement.
e. Input thermal-magnetic molded-case circuit breaker disconnect with interrupting capacity rated in RMS symmetrical amperes as required, and labeled in accordance with UL standard 489. The disconnect shall be mounted inside the controller enclosure and shall have door interlocks and a handle with provisions for padlocking in the "Off" position.
f. Manual speed adjustment.
g. Indications of power "On", drive "Run", and drive "Fault". Indication of these parameters shall be provided by full voltage type LED pilot lights. Lamps shall be easily replaceable from the front of the indicating light.
h. Elapsed time meter.
i. Speed indication - calibrated in percent rpm.
j. Control circuits of not more than 115 volts supplied by internal control power transformers. Control power transformers shall have additional capacity as required by external devices indicated on the

Drawings. Control power transformers shall be equipped with two primary leads fused, one secondary lead fused, and one secondary lead grounded.

k. Automatic controller shutdown on overcurrent, overvoltage, undervoltage, motor overtemperature and other drive fault conditions. Controller shutdown shall be manually reset type. Terminals shall be provided for control wiring from motor temperature switches, or a motor protection relay located in the drive enclosure.

l. Diagnostic indicators that pinpoint failure and fault conditions. Indicators shall be manually reset to restore operation after abnormal shutdown.

m. Accept a remote 4-20 mA speed control signal.

n. Process control output for remote 4-20 mA speed indication, rated 0 to 100 percent speed.

o. Spare interlock contacts rated 5 amperes at 120 volts ac, wired separately to the unit terminal board. One NO and one NC isolated spare interlock shall be furnished with each drive. Additional interlock contacts shall be provided as indicated on the Drawings.

p. Drive fault and run status contacts for remote indication, rated 5 amperes at 120 volts ac.

q. Speed droop feature, which reduces the speed of the drive on transient overloads. The drive shall return to set speed after the transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive shall automatically compensate to prevent drive trip.

r. Individual adjustable speed profile settings for start, stop, entry, slope, and minimum and maximum speed points.

s. Coast, controlled ramp, or dc injection selectable modes of stopping.

t. Not used.

u. Adjustable PWM carrier frequency. The inverter output section shall be provided with adjustable PWM carrier frequency from 500 Hz to at least 8 kHz.

v. Noise level of installed equipment shall not exceed 85 dB, as measured by an appropriate calibrated instrument. The required sound level limit shall be met at a minimum of four locations, each not more than 3 feet [0.9 m] above the floor and not more than 10 feet [3 m] from the equipment. This requirement shall apply to all drives, motors, filters, reactors, and transformers supplied with the drive.

2-5.02. Diagnostics. Diagnostic indicators on the face of the drive shall display the type of fault responsible for drive shutdown, warning, or failure. If two or more faults occur

simultaneously, the diagnostic segment shall record or indicate each condition. The drive shall be capable of storing 6 events.

2-5.03. Motor Protection Relay. Not used.

2-6. TESTING. All power switching components shall be pre-run under anticipated operating temperature and load conditions. Any alternative testing procedures shall be submitted and pre-approved before proceeding.

2-6.01. Factory Testing. After the drive system has been assembled at the manufacturer's facility, it shall be tested for at least 4 hours before it is shipped. The complete drive system, including all peripherals, shall be factory tested under simulated operating conditions, including normal operating sequences and fault conditions. Contact closure inputs and simulated driven-outputs shall be connected to the system input/output modules.

A test report summary indicating satisfactory final test results shall be submitted to Engineer before shipment of the equipment.

2-6.02. Secondary Factory Testing. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with Electrical Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-2.02. Installation Supervision. Not Used.

3-3. FIELD HARMONIC DISTORTION TEST. Not used.

3-4. TRAINING OF OWNER'S PERSONNEL. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

Up to 10 employees of Owner, shall be trained in the proper operation, troubleshooting, and maintenance of the equipment. Training shall be conducted by a qualified representative, and shall consist of combined classroom and hands-on instruction. Training shall be conducted at a place and time mutually agreeable to Owner and the drive manufacturer.

End of Section

Section 16220

COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 – GENERAL

1-1. SCOPE. This section covers single and three-phase, small (fractional) and medium (integral) horsepower, alternating current motors rated 500 horsepower and less (NEMA MG1).

Motors shall be designated and coordinated with the driven equipment and shall be located as indicated on the Drawings.

1-2. GENERAL. Motors furnished under driven equipment Specification sections shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

Where applicable, individual motor data sheets have been developed which specify additional requirements for specific motors.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all motors, unless otherwise specified. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Governing Standards. Motors furnished under this section shall be designed, constructed, and tested in accordance with the latest version of NEMA MG 1, NEMA MG 10, and IEEE 112, Test Method B.

1-2.04. Nameplates. All motor nameplate data shall conform to NEMA MG 1 requirements.

1-3. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Motors

Name of manufacturer.
Type and model.
Type of bearing and method of lubrication.
Rated size of motor, hp [kW], and service factor.
Temperature rise and insulation rating.
Full load rotative speed.
Net weight.
Efficiency at full, 3/4, and 1/2 load.
Full load current.
Locked rotor current.
Space heater wattage, where applicable.
Motor temperature switch data, where applicable.
RTD data, where applicable.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

Operation and maintenance manuals shall include the following:

a. Assembly, installation, alignment, adjustment, and checking instructions.

b. Lubrication and maintenance instructions.

c. Guide to troubleshooting.

d. Parts lists and predicted life of parts subject to wear.

e. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

f. Test data and performance curves, where applicable.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Service conditions for motors shall be as specified in the driven equipment Specification sections. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or service environment. Where site elevation and

ambient temperature is not specified in the driven equipment Specification sections, the motors shall be designed for the following.

Site elevation	Below 3,300 ft [1,000 m]
Ambient temperature	40 °C

Unless specified otherwise, all motors shall be designed for full voltage starting and to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Motors utilizing a reduced-voltage, autotransformer starter shall be capable of reduced-voltage starting at a 65 percent tap setting.

Motors utilizing a reduced voltage solid state starter shall be capable of starting at 50% of the specified voltage.

When powered from an adjustable frequency drive (AFD), motors shall be inverter duty and specifically selected for service with an adjustable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by AFDs shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

The number of starts per hour for motors shall be rated for the load cycling requirements of NEMA MG 10.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Unless otherwise specified in the attached motor data sheet(s), design and construction of each general-purpose motor shall be as specified herein. Motor voltage, frequency, speed, service factor, and insulation class shall be as follows.

Motor voltage.	460, 3 phase for ½ horsepower and larger, 120, single phase for smaller than ½ horsepower
Frequency.	60 Hz
Speed.	Constant speed
Service factor.	1.0 , except for AFD driven motors which shall be 1.15
Insulation class and temperature	Class F with 90^{o} C rise at 1.15 SF

rise above 40^{o} C design ambient (by resistance method.	
Enclosure.	Totally enclosed fan cooled
Main conduit box sized to include.	Main motor leads and space heater leads where space heaters are specified

2-2.01. Nameplate Horsepower. Motor nameplate horsepower [kW] shall be equal to or greater than the maximum load imposed by the driven equipment.

2-2.02. Enclosures. All motors shall be self-ventilated. All self-ventilated open type motors, including those with dripproof, splashproof, and weather protected enclosures, and the fan covers of totally enclosed fan cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.

2-2.02.01. Totally Enclosed Motors. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Frames, bearing brackets, external terminal housings, and fan covers for fan cooled motors shall be cast iron. External cooling fans for fan cooled motors shall be fabricated of brass, bronze, aluminum alloy containing not more than 0.2 percent copper, malleable iron, or plastic. All plastic fans shall be fabricated of a reinforced thermosetting plastic and shall be UL approved.

2-2.02.02. Outdoor Motors. Outdoor motors shall have NEMA weather protected enclosures. All exposed metal surfaces shall be protected, where practical, with a corrosion resistant polyester coating. Exposed uncoated surfaces shall be of a corrosion resistant metal. Enclosure exterior and interior surfaces, air gap surfaces, and windings shall be protected with a corrosion resistant polyester, polyurethane or epoxy coating.

2-2.02.03. Motors for Hazardous Locations. Motors for hazardous locations shall be in accordance with the NEC and of the correct type enclosures for the particular service as specified in NEMA MG 1. Motors shall meet the requirements of UL 674.

2-2.02.04. Encapsulated Windings. Not used.

2-2.02.05. Severe Duty Chemical Service Motors. Motors shall be provided with special corrosion-resistant finish and encapsulated windings meeting the requirements of NEMA MG1-1.27.2 and IEEE 841.

2-2.03. Main Conduit Boxes. The main conduit box shall be in accordance with NEMA MG 1. The main conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90-degree increments. A gasket shall be furnished

between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line Drawings.

The main conduit box shall be oversized at least one size larger than NEMA standard. The main conduit box shall be sized for all indicated accessory leads.

Motors furnished in NEMA 320 frame series and larger shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.

2-2.04. Leads. Motor power leads shall be wired into the main conduit box. Unless otherwise specified, space heater leads shall be wired into the main conduit box. All motor leads and their terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Each lead marking shall be visible after taping of the terminals.

All motors rated 100 horsepower [74 kW] and larger, and all vertical motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

Leads for dual-voltage rated or for multispeed motors shall be easily connected or reconnected in the main conduit box for the operating voltage or for the specified speeds. Permanent instructions for making these connections shall be furnished inside the main conduit box or on the motor frame or nameplate.

2-2.05. Terminals. Cable type leads shall be provided with Burndy Type YA or acceptable equal compression type connectors.

2-2.06. Grounding Connections. All motors shall be furnished with a ground connection.

2-2.07. Bearings. All bearings shall be self-lubricating, shall have provisions for relubrication, and shall be designed to operate in any position or at any angle.

Motor bearings shall be antifriction type with L_{10} life rating of 40,000 hours in accordance with ABMA Standards.
All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy relubrication from the outside of the motor while the motor is in service, as necessary.

2-2.07.01. Insulated Bearings. Motors over 100 horsepower controlled by an adjustable frequency drive shall be furnished with one insulated bearing. The insulated bearing shall be installed on the non-drive end of the motor.

2-2.08. Rotors. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced to 0.08 in./sec [2.03 mm/s] or less.

2-2.09. Shafts. Shafts shall be furnished with corrosion resistant treatment or shall be of a corrosion resistant material.

2-2.10. Torque Characteristics. Motors rated 200 horsepower [149 kW] and less shall have torques and locked-rotor current in accordance with NEMA MG 1, Part 12.

2-2.11. Motor Space Heaters. Motors 1 horsepower and larger shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply.

2-2.12. Temperature Sensing Devices. Each motor controlled by an adjustable frequency drive shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amps at 120 volts ac. The contacts shall be wired in series with the end leads brought out to the motor terminal box.

2-2.13. Motor Shaft Grounding Ring. Each motor controlled by an adjustable frequency drive shall be furnished with a maintenance free, conductive micro fiber, shaft grounding ring with circumferential micro fibers to discharge electrical shaft currents within the motor. Motor shaft grounding ring shall be installed on the drive end on the motor shaft. Shaft grounding ring shall be installed by the motor's manufacturer in accordance with grounding ring manufacturer's recommendations.

2-2.14. Assembly. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

2-2.15. Efficiency. Motors shall be premium efficiency type and shall have a NEMA nominal efficiency nameplate value equal to or greater than values indicated in the following table. Efficiency shall be determined in accordance with IEEE 112, Test Method B.

Vertical motors shall have efficiency values equal to or greater than those indicated in the following table minus 0.50.

Motor		Nominal Efficiency Values				Nominal Efficiency Values			
kW	hp	Open Drip Enclosure				TEFC Enclosure			
		3600 rpm	1800 rpm	1200 rpm	900 rpm	3600 rpm	1800 rpm	1200 rpm	900 rpm
0.7	1	84.0	85.5	82.5	75.0	77.0	85.5	82.5	75.5
1.1	1.5	84.0	86.5	86.5	78.0	84.0	86.5	87.5	80.0
1.5	2	85.5	86.5	87.5	86.5	85.5	86.5	88.5	85.5
2.2	3	85.5	89.5	88.5	89.5	87.0	89.5	89.5	86.5
3.7	5	86.5	89.5	89.5	89.5	88.5	89.5	89.5	85.5
5.6	7.5	88.5	91.0	90.2	88.5	90.0	91.7	91.0	86.5
7.5	10	89.5	91.7	91.7	91.0	91.0	91.7	91.0	91.0
11.2	15	90.2	93.0	91.7	91.0	91.0	92.4	92.0	91.0
14.9	20	91.7	93.0	92.4	92.0	92.0	93.0	92.0	91.0
18.7	25	92.4	93.6	93.0	92.0	92.0	93.6	93.0	91.0
22.4	30	93.0	94.1	93.6	93.0	92.4	93.6	93.0	93.0
29.8	40	93.0	94.1	94.1	93.0	92.4	94.1	94.1	93.0
37.3	50	93.0	94.5	94.1	93.0	93.0	94.5	94.1	93.0
44.8	60	93.6	95.0	94.5	94.0	93.6	95.0	94.5	93.0
56	75	94.0	95.0	95.0	94.0	93.6	95.4	95.0	94.0
74.6	100	94.5	95.4	95.0	95.0	94.1	95.4	95.0	94.0
93.2	125	95.0	95.4	95.0	95.0	95.0	95.4	95.0	94.0
112	150	95.0	95.8	95.4	95.0	95.0	95.8	95.8	94.0
149	200	95.4	95.8	95.4	95.0	95.4	96.2	95.8	94.1
186	250	95.0	95.8	95.4	95.0	95.8	96.2	95.8	94.5
224	300	95.4	95.8	95.4		95.8	96.2	95.8	

Motor		Nominal Efficiency Values				Nominal Efficiency Values			
kW	hp	Open Drip Enclosure				TEFC Enclosure			
		3600 rpm	1800 rpm	1200 rpm	900 rpm	3600 rpm	1800 rpm	1200 rpm	900 rpm
261	350	95.4	95.8	95.4		95.8	96.2	95.8	
298	400	95.8	95.8	95.8		95.8	96.2	95.8	
336	450	95.8	96.2	96.2		95.8	96.2	95.8	
373	500	95.8	96.2	96.2		95.8	96.2	95.8	

2-3. ACCESSORIES.

2-3.01. Special Tools and Accessories. Motors requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor shall be provided with lifting eyebolts or lugs and appropriate fittings for adding bearing lubricant. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2-4. ANCHORS. Contractor shall furnish suitable anchors for each item of equipment as required for driven equipment.

2-5. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits as required .At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3-1. INSTALLATION. Each motor shall be installed in accordance with the Equipment Installation section.

End of Section

Section 16320

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1-1. SCOPE. This section covers compartmented, tamper-resistant, weatherproof transformers for mounting on concrete pads. The transformers shall be furnished, installed, and tested as specified herein and as indicated on the Drawings. Equipment shall meet the following requirements, and the design conditions and features specified herein.

Transformer equipment shall be designated and located as follows:

Tag numbers	TP1, TP2
Transformer designations	TX
Location of transformers.	In front of PG Building at ICWRC

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer. Minimum clear working space in front of transformers shall conform to NEC Table 110-34(A).

1-2.04. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except when required by tests.

1-2.05. Governing Standards. All equipment to be furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

ANSI C57.12.00 and C57.12.27 (general)

ANSI C57.12.70 and C57.12.80 (connections and terminology)

ANSI C57.12.90 (test code)

ANSI/IEEE C57.109 (transformer damage curves and protection)

ANSI C57.12.26 (dead-front high-voltage bushings)

ANSI / IEEE 386 (separable connectors)

The equipment shall also conform to all the applicable standards of ANSI, NEMA, UL, and NEC.

1-2.06. Nameplates. A nameplate with unit description shall be provided on each transformer. Nameplates shall be black and white laminated phenolic material of suitable size, engraved with 3/4 inch [19 mm] high letters. The engraving shall extend through the black exterior lamination to the white center.

An instruction nameplate shall be mounted in the low-voltage compartment and shall be readable with cables in place. All doors giving access to high-voltage parts shall be posted with DANGER - HIGH VOLTAGE - KEEP OUT signs. The signs shall be constructed of heavy gage metal, with red letters on a white background.

1-2.07. System Characteristics. The primary side of the transformer will be connected to an electric system with characteristics specified below.

Incoming (primary) power supply	4.16 kV

Frequency	60 Hz
Type	Three phase
Feed method	Radial

1-3. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the transformer, shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

High-Voltage Section

Catalog and data sheets on high-voltage bushings, bushing wells, bushing inserts and separable connectors, metal oxide varistor elbow type arresters, load-break switch, tap changer, and fuses.

Transformer

Elevation, plan, weight, and nameplate.

Low-Voltage Section

Catalog and data sheets on low-voltage bushings and terminals.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE DATA AND MANUALS. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Transformers shall be equipped to be handled by a crane.

1-6. SPARE PARTS. Spare parts shall be provided as specified below.

Spare Parts	Quantity
Fuse links for primary bayonet fuses	One set
Fuse links for cartridge fuses	One set

Control fuses	Five of each size and type

Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

1-7. COORDINATION STUDY. A coordination study of the power distribution system will be conducted in accordance with the Electrical section. The equipment manufacturer shall provide the following information to Engineer with the initial equipment shop drawing submittal:

Protective fuse curves for each current-limiting fuse.

Coordination curves for each circuit breaker.

Transformer damage curves and protection evaluated in accordance with ANSI/IEEE C57.109 for each transformer.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. Each transformer shall be a product of a manufacturer who has supplied such equipment for at least 5 years.

The equipment shall be manufactured by ABB Power T&D, Cooper Power Systems, General Electric, MGM Transformer, Schneider Electric, Siemens, VanTran Industries, or Virginia Transformer, without exception.

2-2. CONSTRUCTION. Each transformer shall be tamper-resistant and weatherproof, with integral high-voltage and low-voltage compartments, and shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the Drawings or specified herein.

2-2.01. Sills and Anchors. The Contractor shall furnish and install steel channels, floor sills, and anchor bolts required by the equipment manufacturer for proper installation.

2-2.02. Enclosure. The transformer tank and terminal compartments shall be bolted together to form an integral unit of weatherproof construction, suitable for outdoor installation. The transformer shall be completely enclosed, with one high-voltage and one low-voltage compartment door. No externally removable bolts, screws, or other fastening devices shall be used (with the exception of pentahead bolts for security) that provide access to the energized parts within the enclosure. The enclosure shall be of tamper-resistant design.

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-2.03. Terminal Compartments. Full height, air-filled, dead-front incoming and outgoing terminal compartments with hinged doors shall be located side by side, separated by an isolation barrier. The low-voltage compartment shall be on the right when facing the transformer. The fastenings of the high-voltage compartment door shall not be accessible until the low-voltage compartment door has been opened. The low-voltage compartment door shall have a 3-point latching mechanism with vault type handle and provisions for a single padlock. The doors shall be equipped with stainless steel lift-off type pin hinges and doorstops to hold the doors open when working in the compartments. The doorsills shall be removable to permit the transformer to be rolled or skidded into place over conduit stubs. Each compartment shall be suitable for installation of incoming and outgoing cables through the bottom. A tank-grounding pad shall be furnished in each compartment.

2-2.04. Transformer Section. Each transformer shall be 3 phase self cooled less-flammable liquid-insulated type. Less-flammable liquid shall be fire resistant hydrocarbon type. Transformers with silicone fluid will not be acceptable. The kVA and voltage ratings shall be as indicated on the Drawings and as specified herein. The average temperature rise of the windings, measured by resistance, shall not exceed 65°C when the transformer is operated at rated kVA output at an average ambient temperature of 30°C over 24 hours, with a maximum of 40°C.

The primary winding shall have four 2-1/2 percent fully rated taps, two above and two below rated voltage. The tap-changer shall be used only when the equipment is de-energized and shall be operated with a hot-stick tool.

The basic impulse level (BIL) of the high-voltage windings shall conform to the following:

Phase to Phase Voltage - kV	BIL Voltage - kV
2.4	45
4.16 & 4.8	60
7.2 & 8.3	75
12.0 through 14.4	95
24.9 delta	150
24.9 wye	125
34.5 delta	200
34.5 wye	150

Transformers shall have the following impedances at their lowest self-cooled ratings:

Transformer Size - kVA	Impedance - percent
75, 112.5, & 225	4.0
300 & 500	4.5
750 & 1000	5.75
1500 & 2000	5.75
2500 & 3000	5.75
3500, 3750, & 5000	6.5

The transformer tank shall be of sealed construction, with a welded cover. A bolted tamper-resistant handhole shall be provided in the cover for access to internal connections. The tank shall have provisions for installation by lifting, jacking, or rolling into position. The transformer shall be equipped with a liquid level indicator; a pressure relief device; and standard provisions for filling, draining, and sampling.

Transformers shall meet DOE 10 CFR Part 431 standard for energy efficiency.

2-2.05. High-Voltage Terminations.
The high-voltage terminations and equipment shall be dead-front type conforming to ANSI C57.12.26. Dead-front construction bushings shall be either universal bushing wells or one-piece integrated bushings for use with separable connectors. Six bushing wells shall be provided with ratings of 600 A. Bushings shall be externally clamped and front removable. Each bushing shall have an adjacent parking stand.

2-2.06. Switches and Fuses. Primary switches shall be furnished. Switches shall be internal, liquid-immersed two-position load break type. The size and ratings of the switches shall be as follows.

Voltage	15 kV
Basic Impulse level	95 kV
Load make & break ampere rating	600 A
Continuous ampere rating	600 A
Make and latch ampere rating symmetrical	10,000 A
Momentary ampere rating, symmetrical	10,000 A

2-2.07. Secondary Terminations. The secondary terminations shall consist of low-voltage bushings. The bushings shall be of molded epoxy, and shall be provided

with blade-type spade terminals with NEMA standard hole spacing arranged for vertical takeoff. The low-voltage neutral shall be an insulated bushing, grounded to the tank by a removable link.
2-2.08. Shop Painting. All iron and steel surfaces, except stainless steel and machined surfaces, shall be shop painted with the manufacturer's standard coating to a minimum thickness of 3 mils. Finish color shall be ANSI 61 for indoor and outdoor equipment. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup painting of damaged coatings.

The underside of equipment installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside shall be defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting.

2-3. ACCESSORIES.

2-3.01. Special Tools and Accessories. All special tools and accessories necessary for testing and maintenance of the equipment shall be furnished.

2.3.01.01. Hot-Stick Tool. An insulated hand-held epoxy fiberglass tool shall be furnished with the transformer. The tool shall have a retracted length of less than 5 feet [1.5 m], extended lengths of 8 and 12 feet [2.4 and 3.6 m], and shall have a disconnect type head. The tool shall be manufactured and tested according to OSHA specifications.

2-4. SHOP TESTS. All standard factory tests required by the ANSI/IEEE C57.12.90 test code shall be performed.

PART 3 - EXECUTION

3-1. INSTALLATION. The transformer will be installed in accordance with the Electrical Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract price.

End of Section

Section 16425

SWITCHBOARDS

PART 1 - GENERAL

1-1. SCOPE. This section covers switchboard equipment, which shall be furnished as specified herein and as indicated on the Drawings. Switchboards shall meet the following requirements, and the design conditions and features.

Switchboards shall be designated and located as follows:

Tag number(s)	TPS	HH
Switchboard designation(s)	SWBD	SWBD
Location of switchboard(s)	ICWRC Electrical Equipment Enclosure	SRWRC Electrical Equipment Enclosure

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Dimensional Restrictions. Layout dimensions will vary between manufacturers, and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1-2.04. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective

workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1-2.05. Governing Standards. All equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

NEMA PB 2 and UL 891 (switchboards);
NEMA AB1 and UL 489 (molded-case circuit breakers);
ICS-6 (enclosures);
NEMA PD 2.2 (Ground Fault Protection).

The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

Equipment covered by this section shall be listed by UL. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be conducted at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.

1-2.06. Nameplates. Each switchboard section shall have a nameplate permanently affixed to it, listing the following information:

Name of manufacturer

System voltage

Main bus rating

Type

Manufacturer's shop order number and date

In addition, each circuit breaker and instrument on the front of the switchboard shall have a suitable nameplate. Each incoming line section shall be furnished with a nameplate to indicate the power source or substation from which it is fed. The nameplates for the distribution circuit breakers shall indicate the equipment fed through the breaker. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/4 inch [19 mm] high letters for section and

circuit breaker identity and 1/8 inch [3 mm] letters for other information. The engraving shall extend through the black exterior lamination to the white center.

Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

1-2.07. System Characteristics. The switchboard will be connected to a power system with characteristics as specified below.

Voltage rating	480 V
Frequency	60 Hz
Type	Three phase
Grounding	Solid

1-3. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the switchboard, shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Switchboard

Elevation, plan, conduit entrance locations, and weight.
Electrical characteristics of breakers including voltage, frame size and trip ratings, withstand ratings, and equipment short circuit ratings.
Time-current characteristic curves of all overcurrent protective devices on full size (11x14) transparency paper.
Nameplate legends and equipment schedule.
Switchboard instrument details.
Size and number of bus bars per phase, neutral and ground.
Single-line and control wiring interconnection diagrams.
Metering section details.
Shop test report.
Installation report.
Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer’s descriptive bulletins and product sheets.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE DATA AND MANUALS. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-5. SPARE PARTS. Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

Spare Parts	Quantity
Fuses	100% replacement set

1-6. PROTECTIVE DEVICE STUDY. A protective device study of the power distribution system will be conducted as specified in the Electrical section. The equipment manufacturer shall provide the following information to Engineer with the initial equipment drawing submittal:

Protective relay coordination curves for each solid-state trip device.

Time current curves shall be provided for the following circuit breakers:
- Main breaker
- Tie breaker
- Largest feeder breaker
- Smallest breaker

Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

1-7. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Switchboards shall be equipped to be handled by a crane. Where cranes are not available, switchboards shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. The switchboard shall be manufactured by Eaton, General Electric, Schneider-Electric, or Siemens without exception.

2-2. CONSTRUCTION. All equipment furnished under this section shall be front connected, and shall be designed and constructed in accordance with the following requirements and as indicated on the Drawings.

2-2.01. Enclosure. Switchboards SWBD-HH and SWBD-TPS shall be of deadfront, modular type construction with the required number of vertical sections bolted together to form one rigid, NEMA Type 1 metal-enclosed unitAll sections shall be aligned in both front and rear. The switchboard frame shall be of formed UL gauge steel, rigidly bolted together to support all cover plates, buses, and circuit breakers. Steel base channels shall be bolted to the frame. Each section shall have a removable top plate and an open bottom for installation and termination of conduit. All front covers shall be removable with a single tool and all doors shall be hinged, with removable hinge pins. Enclosures shall have frontaccess, and shall be designed to be installed against a wall.

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-2.02. Busing. The main a bus shall be tin-plated copper and shall be of sufficient size to limit the temperature rise to 65°C, based on UL tests. End sections shall be predrilled for units to be added in the future. The bus rating shall be as follows:

	SWBD-HH	SWBD-TPS
Bus current rating.	1200 A	4000A
Bus fault rating (symmetrical).	50,000 A	100,000A

2-2.02.01. Neutral Bus. A tin-plated copper neutral bus shall be provided for SWBD-HH through all vertical sections and shall be rated full capacity.

2-2.02.02. Neutral Pad. Not used.

2-2.03. Ground Bus. The ground bus shall extend the entire length of the switchboard and shall be firmly secured to each vertical section. A ground lug shall be provided at each end of the ground bus for connection to building grounding system with 4/0 AWG bare copper cables. Other ground lugs for feeder circuits shall also be supplied as indicated on the Drawings.

2-2.04. Incoming Line Sections. Incoming line sections shall be provided as shown on the one-line diagram and as specified herein.

Number of incoming line sections 2

Service entrance rated	No
Incoming cable entrance	Bottom

2-2.04.01. Cable Pull Box. Not used.

2-2.04.02. Busway Entry Compartment. Not used.

2-2.04.03. Power Utility Metering Compartment. Not used.

2-2.04.04. Incoming Line Metering Compartment. The incoming line section(s) shall be provided with a microprocessor-based, digital power meter. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Phase currents, phase voltages, watts, vars, power factor, frequency, watt-hours, watt demand, and total harmonic distortion waveforms shall be available for display. Metering units shall also include a display with touch screen monitor on the front of the equipment. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kvar limit, voltage sequence reversal, underfrequency, and overcurrent. The metering package shall be capable of Ethernet/IP communication for remote monitoring. The digital power meters shall be Allen-Bradley “Power Monitor 5000”, Eaton "Power Xpert Meter 4000", GE "EPM9450", Schneider-Electric "PowerLogic Model CM4000T", or Siemens “9410 Series”.

Sufficient lengths of communication cable shall be provided for connection of metering units within the switchboard and as indicated on the Drawings.

The unit shall have two isolated 4-20 mA selectable outputs.

2-2.04.05. Surge Protective Devices.

2-2.04.05.01. Scope. Surge Protective Devices (SPD) devices shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the facility's wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.

SPD’s shall be furnished and installed for the electrical equipment indicated (on the Drawings and designated in this section as required and as specified herein. SPD’s shall be installed integral to each switchboard. SPD’s for switchboards shall be rated for high exposure levels.

2-2.04.05.02. Standards.
The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41 and C62.45;

ANSI/IEEE C62.1 and C62.11;

IEEE C62.62;

NEMA LS1;

NFPA 20, 70, 75, and 78;

UL 1449 and 1283

The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

2-2.04.05.03. Environmental Requirements.

a. Operating Temperature: 0°F to +140°F (-18°C to +60°C).
b. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

2-2.04.05.04. Electrical Requirements.

a. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.
b. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.
c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.
d. Protection Modes. Four-wire configured systems shall provide Line-to-Neutral (L-N), Line-to-Ground (L-G), and Neutral-to-Ground (N-G), and Line-to-Line (L-L) protection. Three-wire configured systems shall provide Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.
e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be no less than as follows:

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA

f. UL 1449 Third Edition Voltage Protection Rating (VPR). The maximum VPR for the device (inclusive of disconnect) shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
480 V 3W		1200 V		2000 V

g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.
h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.
i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200 kA symmetrical fault current with 600 volts AC applied.
The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.
j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit.

2-2.04.05.05. Warranty. The manufacturer shall provide a minimum Five Year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

2-2.04.05.06. Installation. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

2-2.04.05.07. Options

a. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL1449 Third Edition listed as such, and the UL1449 Third Edition Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.

b. Dual Form "C" Dry Contacts. The SPD shall be provided with a set of form "C" dry contacts (normally open and normally closed) to facilitate connection to a plant control system or other remote monitoring system. The contacts shall be normally open or normally closed and shall change state upon any alarm condition.

2-2.04.06. Main Breaker. Each incoming line section shall include a fixed mounted insulated case power circuit breaker with a current rating as indicated on the Drawings

Compression type terminals shall be provided for terminating the number and size of copper conductors indicated on the Drawings.

The incoming line circuit breakers shall be furnished with a captive key interlock to prevent both incoming circuit breakers and the tie breaker from being closed at the same time.

2-2.05. Tie Breaker Section. Each tie breaker section shall include a fixed mounted insulated case power circuit breaker with a current rating as indicated on the Drawings

2-2.06. Distribution Section. The distribution section shall be provided to house branch circuit breakers as indicated on the Drawings. Circuit breakers shall be molded case type, with a manually operated stored energy mechanism. Molded case circuit breakers shall have magnetic/thermaltrip mechanisms.

Circuit breakers shall be removable from the front without disturbing adjacent units. The switchboard shall contain space for future units as indicated on the Drawings. The cable entry for the distribution section shall be from the bottom.

2-2.07. Molded Case Circuit Breakers. Molded case circuit breakers shall be panel mounted. Circuit breakers shall be rated to interrupt and withstand an available fault current as indicated on the drawings at the system line voltage. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically tripfree. Circuit breakers shall have trip units as specified herein. Electronic trip units shall be complete with built-in current transformers. The ampere rating of the trip unit shall be as indicated on the Drawings.

The trip unit shall have adjustable settings for continuous amperes, instantaneous pickup, and short-time pickup. Where specified herein, the trip unit shall be provided with additional short delay trip time adjustment for better system coordination. Circuit breakers indicated to be rated less than 100 amperes shall be thermal-magnetic types.

Where specified herein, built-in ground fault protection shall be provided having adjustable pick-up ratings not exceeding 1,200 amperes, time delay adjustable from 0.1 to 0.5 seconds, and a neutral ground fault current transformer.

Solid-state electronic trip breakers shall have built-in test points for testing long delay, instantaneous, and ground fault functions of the breaker by means of a 120 volts AC operated test kit.

2-2.08. Insulated Case Power Circuit Breakers. Insulated case breakers shall be UL listed for operation at 100 percent of continuous current rating. The circuit breakers shall be rated to interrupt and withstand an available fault current of 50,000A at system line voltage. The breaker control faceplate shall include color-coded visual indicators for open and closed positions as well as mechanism charged and discharged positions.

Manual push buttons shall be provided for opening and closing the breaker. Internal control power transformers shall be provided to furnish control power for insulated case power circuit breakers

Each breaker shall be furnished with a solid-state tripping system consisting of three current sensors, a solid-state trip device, and shunt trip. The solid-state element shall have long delay current pickup, short delay pickup, instantaneous pickup, ground fault pickup and fault trip indicators. All elements of the solid-state trip device shall be of the sealed potentiometer type providing adjustable current pickup in percentage of current sensor primary rating and time delay adjustments. The current sensor primary ampere rating shall be as indicated on the Drawings.

The breaker shall have built-in test points for testing long delay, short delay, instantaneous, and ground fault functions of the breaker by means of a 120 volts AC operated test kit.

2-2.09. Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61. Internal surfaces shall be coated with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings.

The underside of equipment to be installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during Shipping and installation. The underside is defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting. The coating may be factory or field applied.

2-3. SHOP TESTS. After the equipment has been completely assembled, it shall be shop tested for general operating conditions, circuit continuity, and high potential and other standard tests for the particular class of equipment as defined by industry standards. Test voltage shall be 1000 volts, and minimum acceptable value for insulation resistance is 2 megaohms. Four certified copies of the test results shall be submitted to Engineer before the equipment is shipped.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with the Electrical Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

End of Section

Section 16491

BYPASS-ISOLATION AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1-1. SCOPE. This section covers indoor automatic transfer switches, which shall be furnished, and tested as specified and as indicated on the Drawings.

Automatic transfer switch equipment shall meet the design conditions and features.

Automatic transfer switch equipment shall be designated and located as follows:

Tag number(s).	4
Transfer switch designation(s).	ATS
Location of transfer switch(es).	SRWRC Headhouse

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected , and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If stipulations in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1-2.04. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective

workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

1-2.05. Governing Standards. The equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

UL 1008;
NFPA 110;

The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

The automatic transfer switch shall be UL listed for use in emergency power systems in accordance with Article 700, Emergency Systems.

1-2.06. Nameplates. Nameplates with designation of each control or indicating device shall be mounted on the switch enclosure. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/4 inch [19 mm] high letters for section identity and 1/8 inch [3 mm] letters for other information. The engraving shall extend through the black exterior lamination to the white center.

Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

1-2.07. System Characteristics. The equipment will be connected to a power system with characteristics as specified below:

Voltage, phase	480, 3-phase V
Frequency	60 Hz
Number of conductors	3-wire

1-3. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the transfer switch, shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Drawings showing front and side views, plan, and weight.
Rating and specifications.
Circuit breaker time-current characteristic curves, if applicable.
Single-line, control schematic, and wiring connection diagrams.
Operation and maintenance and manuals including a list of spare parts.

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE MANUALS. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. The automatic transfer switch shall be a product of a manufacturer who has supplied such equipment for at least 5 years.

The automatic transfer switch shall be manufactured by Automatic Switch Co. (ASCO), GE Zenith Controls, or Russelectric Inc., without exception.

2-2. CONSTRUCTION FEATURES.

2-2.01. Enclosure. The enclosure for the transfer switch shall be as follows:

Type of mounting	Wall mounted
Enclosure rating	Indoor NEMA Type 1

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-2.02. Rating. Automatic transfer switches shall be rated for continuous duty in both normal and emergency positions. The switches shall have the number of poles as specified below, and shall be double-throw. Ampere ratings, and 3-cycle closing and withstand ratings shall be as specified below.

Number of poles	3-pole
Ampere rating and 3-cycle closing and withstand rating	100/35,000 A

2-2.03. Space Heaters. Not used.

2-3. PERFORMANCE AND DESIGN REQUIREMENTS.

2-3.01. Equipment Description. The automatic transfer switches shall transfer electric loads from the normal source of electric power to an emergency source of power as indicated on the Drawings. The transfer switches shall automatically transfer the electrical load circuits upon an interruption or a decrease in the voltage of the normal source of power and shall transfer the loads back to the normal source when it becomes available. The transfer switches shall be furnished without integral overcurrent protection. The switches shall be electrically operated but mechanically held in both the normal and emergency positions. The operating mechanism shall be momentarily energized from the source to which the load is being transferred. All main and arcing contacts and control elements shall be removable from the front of the switches without removing the switch from the enclosure and without removing the power cables. The automatic transfer switches shall be so designed that the load circuits cannot be connected to more than one source of power at a time. The automatic transfer switches shall be magnetic contactor type.

2-3.01.01. Automatic Transfer Switch. The automatic transfer switch shall be an electrically operated double throw switch. Main contacts shall be silver composition. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance. A manual handle shall be provided for maintenance.

Switches composed of molded case breakers, contactors, or similar components not specifically designed for automatic transfer switch applications will not be acceptable.

2-3.01.02. Bypass-Isolation Switch. Not Used.

2-3.02. Control System. The control system shall consist of all control devices necessary to operate the switch as described. The system shall incorporate a microprocessor control module connected to the power transfer components by a wire harness and keyed disconnect plugs. The control module shall be completely enclosed with a protective cover and shall be mounted separately from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on plug-in circuit boards. All interface relays shall be identical and shall be control grade, plug-in type, with dust covers.

All control components shall meet or exceed the voltage withstand capability in accordance with IEEE C37.90.1 and NEMA ICS 1.

2-3.02.01. Performance. The automatic transfer switch shall be designed to function in accordance with the following requirements:

a. The voltage of each phase of the normal source shall be monitored and the pickup voltage shall be adjustable from 85 percent to 100 percent of nominal, and the dropout voltage shall be adjustable from 75 percent to 98 percent of the pickup value. The transfer to emergency will be initiated upon reduction of the normal source to 85 percent of the normal voltage, and retransfer to normal shall occur when the normal source restores to 90 percent of the normal voltage.

b. A time delay to override momentary normal source outages to delay all transfer switch starting signals shall be provided. The time delay shall be field adjustable from 0.5 to 6 seconds and shall be factory set at 1 second.

c. A time delay to retransfer to the normal source shall be provided. The time delay shall be automatically bypassed if the emergency source fails and the normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and shall be factory set at 10 minutes.

d. An in-phase monitor shall be provided to control transfer so motor load inrush currents do not exceed normal starting currents. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and shall permit transfer only at acceptable values of voltage, phase relationship, and frequency differential.

2-3.02.02. Indication. The automatic transfer switch shall include indication features in accordance with the following requirements:

a. A detailed step-by-step operating instruction plate shall be provided on the front of the switch.

b. Indicating lights or microprocessor control display indication shall be provided for, but shall not be limited to, the following:

Normal source available.
Emergency source available.
Automatic transfer switch isolated.
Automatic transfer switch inhibit.
Automatic transfer switch in normal position.
Automatic transfer switch in emergency position.
Automatic transfer switch in test mode.

c. One auxiliary contact shall be provided that is closed when the automatic transfer switch is connected to the normal source and one contact that is closed when the automatic transfer switch is connected to the emergency source.

2-3.03. Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61. Field painting, other than touchup painting, shall not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

2-3.04. Shop Tests. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and for compliance with the governing standards. Certified test results shall be submitted to Engineer before the equipment is shipped.

PART 3 - EXECUTION

3-1. INSTALLATION. The transfer switch will be installed in accordance with Electrical Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An installation check by a representative of the manufacturer is not required.

3-3. TRAINING. The manufacturer’s representative shall provide training of Owner’s personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

Section 16670

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing the design of lightning protection systems and the furnishing and installation of lightning protection equipment for the following structures:

ICWRC Electrical Equipment Enclosure
SRWRC Electrical Equipment Enclosure
SRWRC Stairway Enclosure
SRWRC Primary Clarifiers

Lightning protection systems shall be furnished, installed, and tested as specified. Lightning protection equipment shall meet the requirements specified herein.

Lightning protection systems shall consist of, but not be limited to, air terminals; main, bonding, and down conductors; ground terminals; and all required connectors and fittings required to complete the system.

The lightning protection system shall include the bonding of all roof-mounted mechanical equipment, roof drains, roof mounted ladders, chimneys, antennas, and other roof mounted metal objects.

1-2. GENERAL. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor and obtain all inspections to complete the work as specified, and in compliance with all codes, standards, and regulations.

Contractor shall provide coordination with other contractors and supervision of installation as needed during construction.

The design of the system shall include determination of the overall lightning hazard for the geographic location of the project and for the structures, the selection of Class I and/or Class II materials, the need of corrosion protection for the copper and/or aluminum components used, and consideration of other pertinent factors. The design shall produce a zone of protection from lightning to prevent personal injury, structural damage, and equipment downtime.
Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of UL unless exceptions are noted by Engineer.

The system shall be installed by an installer who has UL listing and subscribes to the UL Follow-Up Service.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Governing Standards. All system components furnished under this section shall be designed in accordance with ANSI/UL 96 - Lightning Protection Components. All lightning protection systems furnished under this section shall be designed, constructed, and tested in accordance with UL 96A – Installation Requirements for Lightning Protection Systems and ANSI/NFPA 780 – Standard for the Installation of Lightning Protection Systems.

Lightning protection systems shall be bonded to grounding electrode systems in accordance with the National Electrical Code.

1-2.04. Workmanship and Materials. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, unless required by tests.

1-3. SUBMITTALS. Complete certification of design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming the system, shall be submitted in accordance with the Submittals Procedures section.
Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. QUALITY ASSURANCE. The lightning protection system shall be inspected and tested after installation by conducting continuity and ground resistance tests as well as a visual inspection. Inspection results and test data shall be submitted in accordance

with the Submittals Procedures section. Upon completion of the installation, Contractor shall apply for and deliver the UL Master Label Certificate of Inspection for each structure/building.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. The system components shall be manufactured by a company that has been specializing in the design and manufacture of UL listed lightning protection equipment for at least 5 years.

2-2. MATERIALS. All manufactured and fabricated components shall conform to NFPA 780 Class I or Class II as needed for the structures on which they will be installed. The system components shall be fabricated from the following metals:

Conductors	Copper.
Air Terminals	Copper or bronze.
Grounding Electrodes	Copper clad steel.
Fasteners	Copper or bronze.
Bimetallic Fasteners	Bronze and aluminum.

Aluminum conductors and air terminals shall be mounted on aluminum surfaces only.

All materials furnished for the lightning protection system shall bear the inspection label of UL.

PART 3 - EXECUTION

3-1. INSTALLATION. The lightning protection system shall be installed in a neat and inconspicuous manner so all components will blend in with the appearance of the building. All conductors shall be concealed or semi-concealed during construction using methods recommended in NFPA 780 and UL 96A.

Air terminals shall have base supports designed for the surface on which they are used and shall be securely anchored. All exposed metal eave troughs, roof vents, guy wires, antennas, and air handling equipment shall be bonded to the lightning protection system in such a way that two paths to ground are provided.

The lightning protection system shall be bonded to structure/building electrical ground rings wherever they are available.

End of Section

Section 16723

FIRE PROTECTION AND SIGNALING SYSTEM

PART 1 – GENERAL

1-1. SCOPE. This section covers the design of a fire protection and signaling system and the furnishing and installation of a fire protection and signaling system. All associated equipment, devices, and controls necessary for proper operation shall be included.

The design of the system shall consist of, but shall not be limited to, a determination of the applicable fire and safety codes; an analysis of the various plant ambient temperatures, noise levels and environments (wet, dusty, oily, corrosive, hazardous, etc.); the number and type of detectors, alarm indicators, and manual stations required; and the proper wiring and mounting configurations.

Peripheral components as specified shall be located as indicated on the Drawings and provided in sufficient number and located as needed to meet all applicable codes.

The signaling system supplier shall coordinate with the mechanical temperature control systems supplier for monitoring of ventilation system flow detection switches.

1-2. GENERAL. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor to complete the work as specified, and in compliance with the codes, standards, and regulations listed below.

1-2.01. CONTRACTOR'S Qualifications. The system design, equipment, installation, and installation supervision furnished under this section shall be provided by a single manufacturer or supplier who has been engaged in the business of supplying fire alarm systems of this type for at least 5 years.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards.

a. Georgia State Fire Marshal's Regulations for Safety to Life from Fire and Emergencies in Buildings and Structures, and General Fire Protection.

b. National Fire Protection Association, NFPA 45, 71, 72, 90A, and 101.

c. City of Atlanta Fire Department Regulations

d. Atlanta City Electrical Code.

e. National Electrical Code, Article 760.

All fire alarm equipment and materials, devices, and assemblies shall be listed and/or labeled by Underwriters' Laboratories, Factory Mutual, or another accepted testing laboratory for the intended purpose where acceptable to the authority having jurisdiction. The equipment shall not be altered, installed, or modified in any way that would void the label or listing.

All control equipment shall have transient voltage protection devices in compliance with UL 864.

The system controls shall be UL listed for Power Limited Applications according to NEC 760. All circuits shall be marked in accordance with NEC 760-10.

1-2.05. Nameplates. Major components of equipment shall be identified with a permanently affixed nameplate bearing the manufacturer's name and address, and type or style and catalog number of the item.

1-2.06. Tags. Keys and locks shall be furnished with tags bearing stamped identification numbers. Cable and conduit runs, wiring circuits, and all spare parts supplied to maintain the system shall be furnished with hard phenolic or stainless steel tags.

1-2.07. Power Requirements. Power supply to the fire protection signaling panel (FPSP) will be 120 volts, 60 Hz, single phase.

The alarm system shall include an automatically recharged backup power supply with sufficient battery capacity to operate the entire system in the normal

supervisory mode for 24 hours and then sound all alarms for 5 minutes. In the event of power failure, the system shall automatically transfer to the standby batteries.

All external circuits requiring system-operating power shall be suitable for 24 volt dc service and shall be individually fused at the control panel.

1-2.08. Spare Parts. Spare parts as specified below shall be supplied with the fire protection and signalling system. Spare parts shall be suitably packaged for shipment.

Spare Parts	Quantity
Audiovisual alarms	One of each type used

1-3. SUBMITTALS. Complete electrical wiring diagrams; assembly and installation drawings; detailed specifications; and data covering the materials used and the parts, devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with the Submittals Procedures section.

In addition to the submittals to Engineer, Contractor shall submit complete plans and information to the local fire department for review. Contractor shall provide signed and sealed plans by a registered engineer in the state of Georgia where required by local or state requirements. The equipment submittals shall include the following:

A complete description of all system components, including certification of listing by the required testing laboratory.

Complete sequence of operation for all functions of the system.

Complete system wiring diagram for all components and interfaces to equipment supplied under other sections.

Location drawings for all controls, alarm actuating devices, and audiovisual alarm signaling devices.

A listing of the manufacturer's representatives responsible for installation and service.

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

Operation and maintenance manuals.

1-4. SYSTEM DESCRIPTION. The fire protection and signaling system shall be operated and monitored by a fire protection and signaling control panel (FPSP), located as indicated on the Drawings. The system shall automatically initiate fire alarm signals whenever any manual or automatic fire detection device is placed in an alarm mode. The system shall transmit a signal to the municipal alarm connection, HVAC systems, the plant control system, and other plant systems as indicated in the activation sequence herein. The FPSP shall annunciate and sound local alarms for detection device alarm conditions, system trouble, or circuit failure. Alarm signals shall be consistent throughout the building or site. The operation of any alarm initiating device shall cause audible and visual alarms to sound and to be displayed throughout the building as required by applicable codes. A key-accessible reset function shall reset the alarm system after alarm initiating conditions have been cleared.

The system functions shall include ventilation air flow detection monitoring.

The system shall monitor ventilation system flow detection switches and shall provide audiovisual annunciation of ventilation failure (loss of airflow) that is separate and distinguishable from other audiovisual annunciation. The system shall also provide an isolated alarm contact indication to the temperature control system for ventilation failure as indicated in the HVAC sequence of operations on the Drawings.

1-4.01. System Configuration.

a. Initiating device, notification device, and signaling line circuits shall be NFPA 72, 3-4, Class A. The system shall monitor incoming power and standby power. In addition to the FPSP, the system shall include audiovisual alarm units, end-of-line devices, manual pull stations wiring connections to devices, outlet boxes, junction boxes, and all other necessary equipment for a complete operating system.

b. System trouble, including grounded or open supervised circuit, power failure, system battery low voltage, or system failure, shall cause the system to enter a trouble mode and display visual and audible alarms. The visual alarm shall be displayed until the initiating trouble has been cleared.

1-4.01.02. Fire Alarm Activation Sequence. Not used.

1-4.01.02. Ventilation Failure Activation Sequence. The alarm sequence initiated by the deactivation of each ventilation flow detection switch or each set of flow detection switches shall be as follows:

a. Audible alarm indicating devices within the room space and outside each entrance to the room space shall sound a separate and distinguishable code until silenced by the alarm silence switch at the FPSP.

b. Visual alarm indicating devices within the room space and outside each entrance to the room space shall display a continuous strobe pattern until the system is reset.

c. An isolated output contact to the mechanical temperature control system shall indicate ventilation failure as required in the HVAC sequence of operations on the Drawings.

1-4.01.03. Combustible Gas Detection Activation Sequence. Not used.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. All panels and peripheral devices shall be the standard products of a single manufacturer, and the manufacturer's name shall be displayed on each component. The system shall be manufactured by Bosch Security Systems; Gamewell-FCI; Notifier; Siemens Building Technologies; or Simplex Grinnell.

2-2. REMOTE SENSORS.

2-2.01. Fire Alarm Pull Stations. Not used.

2-2.02. Smoke Detectors. Not used.

2-2.03. Heat Detectors. Not used.

2-2.04. Audiovisual Alarm Units. Alarm units shall consist of a horn and a Xenon flashtube installed in a surface or semi-flush wall- or ceiling-mounted enclosure. The horn shall have polarized connections with separate leads for in/out wiring for each leg of the associated signal circuit. Sound level shall be 90 dB at 10 feet [3 m].

The visual unit shall operate on 24 volts dc and shall have a white translucent pyramidal lens with the word "FIRE" imprinted in red lettering for fire alarm

circuits, and shall be a distinguishable color for gas detection/ventilation failure alarm circuits. The flash rate shall be 1 to 1.5 times per second.

2-2.05. Auxiliary Relays. Auxiliary relays shall be supplied where required. The relays shall be of high quality and shall be fitted with dusttight plastic covers. The contacts shall be at least 1/8 inch in diameter, of gold-plated silver cadmium oxide, rated for 5 amperes at 115 volts ac.

2-2.06. Addressable Input Modules. Each external dry contact input from gas detection equipment, ventilation flow detection switches, sprinkler system flow switches, and other required auxiliary inputs shall be equipped with addressable input modules designed to provide circuit monitoring and point identification of dry contact inputs.

2-3. PANELS.

2-3.01. Fire Protection and Signaling Control Panel. The control panel shall be an analog/addressable type supervised alarm control panel. The panel enclosure shall be constructed from steel, in compliance with UL 864, with front access door, and shall be surface wall-mounted.

The control panel shall be of modular construction, with solid-state, microprocessor-based electronics, and shall display only the primary controls and functions essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions. A local audible device shall sound during alarm, trouble, or supervisory conditions. The sound that identifies each condition shall be readily distinguishable without having to view the panel. The audible device shall also sound during each key press to indicate that the key has been pressed. The panel shall be fully field programmable from the keypad and capable of downloadable programming from a Windows-based application program. The panel shall include self programming logic capable of automatically programming new addressable field initiating devices.

The following primary controls shall be visible through a front access panel:

Eighty-character liquid crystal display.

Red system alarm LED.

Yellow supervisory service LED.

Yellow trouble LED.

Green "power on" LED.

Alarm acknowledge key.

Supervisory acknowledge key.

Trouble acknowledge key.

Alarm system key.

System reset key.

Manual evacuation (drill).

The control panel shall include the following functions:

Setting of time and date.

LED testing.

Listing of alarm, trouble, and abnormal conditions.

Separate enabling and disabling of each monitor point.

Separate activation and deactivation of each control point.

Changing operator access levels.

Walk-test enable.

Running diagnostic functions.

Displaying software revision level.

Displaying historical logs.

Displaying card status.

Point listing.

The following lists from the points list menu shall be available for maintenance purposes:

All points by address.

Monitor points.

Auxiliary controls.

Feedback points.

Pseudo points.

LED/switch status.

Scrolling through menu options or lists shall proceed in a self-directing manner, guided by prompting messages. The controls for the points list menu shall be located behind an access door.

The control panel shall contain a back lighted 2 line by 40 character liquid crystal display. To conserve standby battery power in the event of an ac power failure, the display shall be lit only during keypad activity.

The display shall consist of both upper case and lower case letters. Lower case letters shall be used for soft key titles and for prompting the user. Upper case letters shall be used for system status information. A cursor shall be visible when information is being entered.

All wiring shall be brought to terminal strips for field connections.

2-3.01.01. Front Panel Operation and Capabilities. Under normal conditions, the front panel shall display a "SYSTEM IS NORMAL" message and the current time and date.

Should an abnormal condition be detected, the appropriate alarm, supervisory, or trouble LED shall flash. The audible signal shall pulse for alarm conditions and sound steady for trouble or supervisory conditions.

The LCD shall display the following information pertaining to the abnormal condition:

Location label (40 characters available).

Type of alarm device - smoke detector, pull station, gas detection, ventilation failure, and water flow sensor.

Point status - alarm, trouble.

Buttons shall be provided to acknowledge alarm conditions and to silence audible alarms in compliance with NFPA 72.

2-3.01.02. Alarm Silencing. When the "ALARM SILENCE" button is pressed, all alarm signals shall cease. Alarm signals shall not be silenced during "alarm silence inhibit" mode.

2-3.01.03. System Reset. Using the "SYSTEM RESET" button shall restore the system to its normal state after an alarm condition has been remedied.

The LCD display shall step the user through the resetting procedure with simple printed messages.

2-3.01.04. Device Status. Complete status of all addressable field devices shall be available through use of the operator keypad and front panel display.

2-3.01.05. History Logging. The system shall be capable of logging and storing 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in a battery-protected random access memory. Each recorded event shall include the time and date of the occurrence.

2-3.01.06. Silent Walk Test with History Logging. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. After logging the alarm, the panel shall automatically reset.

The momentary disconnection of an initiating or indicating device circuit shall be silently logged in the historical data file as a trouble condition. After logging the trouble condition, the panel shall automatically reset.

Should the walk test feature be on for an inappropriate length of time, it shall automatically revert to the normal mode.

The control panel shall be capable of supporting up to eight separate testing groups, one of which may be in a testing mode while the other (nontesting) groups may be active and operating as normally programmed. After testing is completed, testing data may be retrieved from the system in chronological order to ensure device/circuit activation.

Should an alarm condition occur from an active point that is not in walk test mode; it shall initiate the normal alarm sequence.

2-3.01.07. LED Supervision. All LEDs shall be supervised for burnout or disarrangement. Should a problem occur, the LCD shall display the location numbers of the module and the LED to facilitate location of the affected LED.

2-3.01.08. System Trouble Reminder. In the event of a trouble condition within the system, with the audible signal silenced, the trouble signal shall resound at 24 hour intervals as a reminder that the fire protection and signaling system is not 100 percent operational. Both the time interval and the trouble reminder signal shall be programmable to adapt to the application.

2-3.01.09. Operator Access Levels. Operator access to system functions shall be limited by a key switch and multiple levels of password protection.

The following functions shall be protected:

Alarm Silence.

System Reset.

Set Time/Date.

Manual Control.

On/Off/Auto Control.

Disable/Enable.

Clear Historical Alarm Log.

Clear Historical Trouble Log.

Walk Test.

Change Alarm Verification.

Acknowledge keys shall also require privileged access to acknowledge points. If the operator presses an acknowledge key with insufficient access, an error message will be displayed. The points shall scroll with acknowledge key presses to view the points on the list, but the points will not be acknowledged in the database.

2-3.01.10. Wiring. Intermodule wiring for common system functions shall be installed in a supervised cable bus. Disarrangement of the bus shall cause a distinctive "Cable Supervisory" LED to be illuminated in addition to activating the common trouble indicators.

Detector and signal circuits and wiring may be nonpower-limited type and shall comply with the applicable articles of the NEC.

2-3.02. Enclosures. A cabinet of sufficient size shall be provided to accommodate all equipment required. The door of the cabinet shall be equipped with locks and a continuous hinge, providing protection from tampering, yet allowing full view of the various lights and controls. Indoor enclosures shall be of a NEMA type suitable for the area designation. Outdoor NEMA Type 4X enclosures shall be stainless steel.

2-4. CABLE AND RACEWAYS.

2-4.01. Cable. Cable used in the fire protection and signaling system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial fire protection and signaling systems and UL listed for indoor/outdoor installations. All cable required for the system shall be furnished by the Contractor.

2-4.02. Raceways. All cable shall be installed in conduit furnished under this section. All conduit shall conform to the applicable paragraphs of the Electrical section.

PART 3 - EXECUTION

3-1. GENERAL. All work shall be installed as indicated on the Drawings, and in accordance with the manufacturer's diagrams and recommendations, except where otherwise indicated.

All junction boxes furnished hereunder shall be painted red and permanently labeled "FIRE ALARM". A consistent wiring color code shall be maintained throughout the installation.

Installation of equipment and devices that connect to equipment furnished under other sections, or furnished by the Owner, shall be closely coordinated with the suppliers of the equipment and with Owner.

After completion of the installation, Contractor shall clean the inside and the outside of the fire alarm equipment and shall remove all dirt and debris from the site.

3-1.01. Cable. Cable shall be installed as described in the cable installation paragraphs in the Electrical section. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

3-1.02. Raceways. Conduit shall be installed as described in the conduit installation paragraphs in the Electrical section.

3-1.03. Testing. Contractor shall notify Engineer at least 30 days before the performance and acceptance tests are to be conducted. The tests shall be performed in the presence of Engineer, Owner, LOCAL FIRE MARSHAL, or their representatives. The Contractor shall furnish all instruments and personnel required for the tests. A complete test report and letter of completion shall be submitted to Engineer. The tests shall be performed by, or under the supervision

of, a qualified representative of the fire protection and signaling system manufacturer and shall include the following:

a. Verify that the system is free of grounds or open circuits. The FPSP shall indicate when a ground or an open circuit exists.

b. Verify that all alarm signal devices, stations, transmitters, automatic detectors, and supervisory devices are functioning as specified.

c. Test each fire alarm device and circuit. Individually activate each manual initiating station and verify correct alarm operation and control panel response. Individually test each automatic initiating device and verify correct alarm operation, control panel response, and remote equipment operation.

d. Test battery backup systems for specified capacity.

e. Repeat test to verify correction of any defect found in the initial testing.

3-2. TRAINING. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

END OF SECTION

Section 17500

INSTRUMENTATION AND CONTROL SYSTEM

PART 1 – GENERAL

1-1. SCOPE. This section covers the modifications, upgrades, and expansion of an existing instrumentation and control system designated as the Plant Control System (PCS).

The decommissioning of Intrenchment Creek Water Reclamation Center (ICWRC) with resultant pumping of untreated wastewater to the South River WRC (SRWRC) requires additional instrumentation and control systems located at ICWRC and SRWRC. Additionally, upgrades to existing ICWRC & SRWRC Foxboro Distributed Control System (DCS) are required. Modifications and upgrades to ICWRC and SRWRC DCS are detailed under Section 17532.

New 'stand-alone' PLC-based controls will be installed for all new equipment systems at ICWRC Headworks & Transfer Pump Station. New 'stand-alone' PLC-based controls will be installed for all new equipment systems at SRWRC (Headhouse and Chemical Feed). PLC-based controls are referenced under 17500 and 17530. SUPPLIER shall provide PCS integration of multiple equipment supplier provided package control systems under the following sections:

Section 11727 (Chemical Feed Systems)
Section 11330 (Coarse Screen)

All new PLC-based controls will be interfaced to existing ICWRC and SRWRC DCS system via fiber-optic based Ethernet communications connected to Foxboro DCS enclosures (ICWRC located in the Power Generation Building and SRWRC located in Preliminary Treatment Building).

The system shall be furnished as specified, complete with all software, human machine interface (HMI) hardware, input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation.

Note: The Human Machine Interface (HMI) computers and each Operator Interface Terminal (OIT) (OIT located at each Programmable Logic Controller (PLC) panel and every HMI on the DCS system) shall function as a monitoring system, not as a controller, for the process equipment. The computers (HMI or OIT) shall download set points and other information to the PLCs, and the PLCs shall perform all control algorithms, so a temporary failure of the any HMI computer or local PLC OIT will not disrupt plant control.

1-1.02. Associated Sections. This section also includes the equipment and services specified in the following sections.

Section 17532	DISTRIBUTED CONTROL SYSTEM
Section 17530	PROGRAMMABLE LOGIC CONTROLLERS
Section 17550	SOFTWARE CONTROL BLOCK DESCRIPTIONS
Section 17561	PANEL MOUNTED INSTRUMENTS
Section 17562	FLOW INSTRUMENTS
Section 17563	PRESSURE AND LEVEL INSTRUMENTS
Section 17564	PROCESS ANALYTICAL INSTRUMENTS
Section 17565	TEMPERATURE INSTRUMENTS
Section 17566	MISCELLANEOUS INSTRUMENTS
Section 17570	PANELS, CONSOLES, AND APPURENANCES
Section 17580	STATIC UNINTERRUPTIBLE POWER SUPPLY
Section 17581	DC UNINTERRUPTIBLE POWER SUPPLY
Section 17590	NETWORK SYSTEMS
Section 17591	METALLIC AND FIBER OPTIC COMMUNICATION CABLE AND CONNECTORS
Section 17592	DEVICE NETWORK EQUIPMENT

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment. The input/output (I/O) lists are attached as an appendix to the Programmable Logic Controllers section and are indicated on the Drawings and associated equipment system specifications.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings and instrument device schedule attached to this section.

1-2.03. Codes, Permits and Agency Approvals. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where mandated by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.

1-2.04. Supplier's Qualifications. Equipment and software furnished under this section and under other related sections listed in the Scope paragraph above shall be designed, coordinated, and supplied by a single manufacturer or supplier, hereinafter referred to as the System Supplier. The System Supplier shall be regularly engaged in the business of supplying computer-based monitoring, control, and data acquisition systems. The Contractor shall utilize the services of the System Supplier to coordinate all control system related items, to check-out and calibrate instruments, and to perform all testing, training, and startup activities specified to be provided.

The System Supplier shall have the following minimum qualifications:

- The supplier shall maintain a design office staffed with qualified technical design personnel.
- The supplier shall maintain competent and experienced service personnel to service the hardware and software furnished for this project.
- The supplier shall have as a minimum 5 years of experience in the design, coordination and supply of computer-based monitoring, control, and data acquisition systems.

1-2.04.1.a. The Instrumentation and Controls Subcontractor does not have to be the same supplier as the Control System Subcontractor as specified in separate sections of this contract. For this project, the providing of upgrades to the DCS system at Intrenchment Creek and South River facilities will be provided by DCS Configuration Subcontractor as defined under Specification 17532.

1-2.04.1.b. The Instrumentation and Controls Subcontractor shall maintain a fully equipped office/production facility with full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting, and testing the instrumentation and control system specified herein. Qualified repair personnel shall be available and capable of reaching the facility within a 24 hour period.

1-2.04.1.c. Actual installation of the equipment and materials specified by this Division need not be performed by employees of the Instrumentation and Controls

Subcontractor; however, the Instrumentation and Controls Subcontractor shall be responsible for the on-site technical supervision of the installation.

1-2.04.1.d. The Instrumentation and Controls Subcontractor shall furnish equipment and materials, which shall be the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.

1-2.04.1.e. The General Contractor must name his/her proposed Instrumentation and Controls Subcontractor and Control System Subcontractor(s) in the bid documents. These subcontractors shall be experienced and fully qualified to perform their individual scopes of work as specified in the Contract. Resumes, including description of previous related project experience, of all proposed qualified individuals with each Subcontractor that are actually available to perform work associated with their scopes of work shall be included with the bid documents. Substitution of subcontractor personnel during the Contract period without written approval of the Engineer is not permitted. Failure to document sufficient personnel with appropriate experience and qualifications to perform the work proposed is sufficient grounds to disqualify the Contractor and/or Subcontractors from performing or completing the “Scope of Work” associated with this Division.

1-2.04.2.a. The specified control system and instrumentation integration including panel building, instrument calibration, testing, start-up, operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar project installations.

1-2.04.2.b. The control system components shall, as far as practical, be of one manufacturer.

1-2.04.2.c. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.

1-2.04.2.d. The overall system performance shall be demonstrated to and accepted by Owner.
1-2.04.2.e. The application software packages shall be latest versions available, or compatible with existing software currently in use.

1-2.04.3. Systems Integrator Qualifications:

1-2.04.3.a. The following Systems Integrators are pre-qualified to perform the work specified in Division 17 without the need to provide Evidence of Experience:

i) Foxboro, Atlanta, GA

ii) Control Instruments Incorporated (C2I), Atlanta, GA
iii) Kapsch / TrafficCom (Transdyn), Duluth, GA
iv) MR Systems, Norcross, GA
v) Revere Controls, Birmingham, AL
vi) As approved per requirements of this Section or as modified by any Addendums.

1-2.04.3.b. Contractor-proposed Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:

Submit evidence of experience in performing three similar successful projects in the last five years with one project currently in progress or competed within the last two years.

Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.

Submit organization chart and resumes for proposed project personnel.

Submit Training and Certification information. Completion of the following training courses or appropriate portions thereof or possession of the following certifications included with the Systems Integrator's personnel experience requirements described above:

a) Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
b) Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
c) Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
d) Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.
e) Certified training programs, as offered by ISA.

Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.

a) Financial Statement.
b) Balance Sheet.
c) Dun & Bradstreet Report.

This submittal is due no later than two (2) weeks prior to Bid Date. Bidders will be advised of approval or rejection in writing no later than fourteen (14) days prior to Bid Date. Rejected submittals may be supplemented with additional information and resubmitted no later than one (1) week prior to the Bid Date. Bidders making

supplementary submittals will be advised of approval or rejection in writing no later than three (3) days prior to Bid Date. Approval of a completed Evidence of Experience by the Engineer is dependent on his determination that the proposed system integrator has sufficient company experience, company expertise, and experienced qualified personnel in new and remodeling work on municipal instrumentation and control systems, has the ability to understand and perform the Work specified, has sufficient financial resources and has not had a detrimental impact to the scope, schedule and budget of work they performed or work performed by others on prior construction projects.

1-2.05. Coordination. Systems supplied under this section shall be designed and coordinated by System Supplier for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment. All equipment shall be designed and installed in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

1-2.05.01 Pre-Submittal Conference. Arrange a conference between the Supplier of each Section, Contractor, and the Engineer with thirty (30) days after award of the Contract for the purpose of informally discussing in detail and verifying the correctness of the Contractor's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by the Supplier's Engineer and duly authorized representatives of the Contractor and the Engineer.

1-2.06. Related Equipment and Materials. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.

1-2.07. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with System Supplier's equipment drawings and shall be as close as practical to the tag numbers used on the Drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1-3. GENERAL REQUIREMENTS. The drawings and specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by System Supplier, details of such departures and the reasons shall be submitted to Engineer for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

The specifications describe the minimum requirements for hardware and software. Where System Supplier's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

1-3.01. Governing Standards. Equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 - Class A, and NEMA ICS-1-109.60.

1-3.02. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The System Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Engineer. At least three feet of clear access space shall be provided in front of all instrumentation and control system components.

1-3.03. Workmanship and Materials. System Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except for testing.

1-3.04. Corrosive Fluids. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials. System Supplier shall submit certification that the instrument manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.

1-3.05. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

1-3.06. Programming Devices. A programming or system-configuring device shall be provided for systems that contain any equipment that requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of start-up.

1-4. SUBMITTALS. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.

1-4.01. First Stage Submittal. The first stage submittal shall include the following items.

a. A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by System Supplier and this specification.

b. Product catalog cut sheets on all hardware and software items, clearly marked to show the model number, optional features, and intended service of each device.

c. A brief, concise description of the proposed system, including major hardware and software components and personnel training.

d. A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships.

e. Drawings showing floor and wall space or desktop area requirements for all equipment items, including allowances for door swings and maintenance access.

f. Environmental and power requirements, including heat release information for each equipment item.

g. Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

h. A copy of the proposed software licenses for all software associated with the system.

i, Outline for training classes.

j. Sizing calculations. Complete sizing calculations shall be provided for all flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all differential pressure flow elements and shall include the actual scaling factors and units used.

k. Additional Requirements identified in other Division 17 sections.

1-4.02. Second Stage Submittal. Before any equipment is released for shipment to the site and before factory testing is scheduled, the following data shall be submitted.

At System Supplier's option, the first and second stage submittals may be combined.

a. Detailed functional descriptions of all software modules specified and furnished as part of System Supplier's standard system. The descriptions shall be identified with the applicable specification paragraph.

b. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall be to scale and shall include overall dimensions, metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

c. Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If panel terminal designations, inter-device connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the site.

   Provide an individual wiring diagram for each analog loop showing all terminal numbers, the location of the DC power supply, signal polarity, the location of any dropping resistors, surge protection, shielding, grounding, etc. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:

   Each loop diagram shall be divided into areas for identification of device location (e.g. panel face, back-of-panel, field, etc.). Each loop diagram shall list (1) Transmitter Drive Capability, (2) Loop Impedance, (3) Transmitter Reserve Drive Capability. Loop diagrams shall be on 11-inch by 17-inch drawings.

d. Fiber termination diagrams to show all fiber terminations at fiber patch panels and final termination at equipment. Fiber termination diagrams shall show individual fiber type (single or multimode), fiber core/cladding dimensions, fiber colors, circuit identifications, and type of terminator.

e. Review of drawings submitted prior to the final determination of related

equipment shall not relieve System Supplier from supplying systems in full compliance with the specific requirements of the related equipment.

f. Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal.

g. Proposed lesson plans or outlines for all training courses specified herein, including schedule, instructors' qualifications and experience, and recommended prerequisites.

h. Standard system engineering and user manuals describing the use of the system and application programming techniques for creating reports, graphics, database, historical records, and adding new process I/O nodes to the system.

i. Additional Requirements identified in other Division 17 sections.

1-4.03. Third Stage Submittal. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted. Additional requirements are identified in other Division 17 specification sections and below.

1-4.03.01. Schedule. Deliver two (2) copies of manuals not later than the equipment ship date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver balance of manuals to Engineer.

1-4.03.02. 'As-Shipped' Drawings.
Drawings shall be a record of work 'As-Shipped' from the factory and shall be labeled as 'As-Shipped'. One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following 'As-Shipped' drawings as a minimum:

Panel Fabrication Drawings
Panel Wiring, Loop, and Interconnection Drawings.

1-4.03.03. 'As-Installed Drawings'.
Contractor shall submit one (1) reproducible set of complete schematics, wiring diagrams and installation drawings to include all installed field and panel instruments, mounting details, point to point diagrams with a cable, wire, and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as

"AS-INSTALLED". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.

2. Loop Diagrams

   See 1-4.02 specified herein before.

3. Panel Fabrication and Wiring diagrams

   See 1-4.02 specified herein before.

4. Interconnecting Wiring Diagrams

   See 1-4.02 specified herein before.

5. Instrument Installation Details

   See 1-4.02 herein before.

Process and Instrumentation Diagrams: The Engineer will supply the ICM Supplier with one set of the P&ID's for revisions to reflect the final installed system to be updated by the ICM Supplier. The ICM Supplier may use these drawings for producing the final documentation.

Software Documentation: In addition to the reproducible hard copy of drawings and literature generated specifically for the project, two (2) portable USB drives (32GB minimum capacity) shall be submitted to the Engineer with a copy of all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc using computer assisted drawing (CAD). Drawing format shall be "AutoCAD Release 14" or as agreed between Owner, Engineer, and Contractor. Media shall be clearly identified by the following:

a) Project Name
b) Volume Number
c) Software Program Name and Version used to generate the files.
d) Labeled "AS-INSTALLED"

1-5. PREPARATION FOR SHIPMENT. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. System Supplier shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1-6. DELIVERY, STORAGE, AND SHIPPING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.
1-7. SPARE PARTS. Spare parts and consumable items are specified in other sections.

1-7.01. Packaging. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.

1-7.02. Replacement. System Supplier may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

PART 2 - PRODUCTS

2-1. GENERAL REQUIREMENTS. All equipment furnished under each section referenced in SCOPE is a part of this section and shall be selected by System Supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review.

2-1.01. Standard Products. The systems furnished shall be standard products. Where two or more units of the same type of equipment are supplied, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.

To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.

Where redundant hardware is provided, the system shall be capable of performing all specified functions, without reconfiguring hardware or software, with only one device of each category in service.

2-2.01. Factory Assembly. Equipment shall be shipped completely factory assembled, except where its physical size, arrangement, configuration, or shipping and handling limitations make the shipment of completely assembled units impracticable.

2-3. POWER SUPPLY AND INSTRUMENT SIGNAL. Power supply to all control system equipment will be 120 volts, 60 Hz, single phase unless specified otherwise. System Supplier shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system from the power supply receptacles and junction boxes indicated on the Drawings. Power distribution hardware shall include cables and branch circuit overcurrent protection installed in accordance with the electrical section.

Unless otherwise indicated, power supply to the instrumentation will be 120 volts ac provided from a UPS source. Unless otherwise indicated, all transmitted electronic analog instrument signals shall be 4-20 mA dc and shall be linear with the measured variable.

2-3.01. Facility Distribution System. Equipment not indicated to be powered from an uninterruptible power source shall be suitable for being supplied from the facility distribution system and shall be capable of withstanding voltage variations of ±10 percent and harmonics up to the limits of IEEE 519 without affecting operation. System Supplier shall provide voltage conditioning or filtering equipment if necessary to meet the requirements specified.

2-3.02. Power Supplies. Power supplies for voltages other than those listed above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected. DC Power Supplies shall be provided with power supply failure indication for alarming.

2-3.03. Surge Withstand. All equipment shall meet all surge withstand capability tests as defined in ANSI C37.90 without damage to the equipment.

2-3.04. Uninterruptible Power Supply. Uninterruptible power supply (UPS) furnished hereunder to power the PLC equipment, communications equipment, and field instrumentation is specified under Sections 17580. System Supplier shall be responsible for coordinating the size of each UPS unit with the equipment furnished hereunder, and shall advise Engineer if a unit of higher capacity is necessary.

2-3.05. Field Device Alarm (Fail-Safe) Condition States. All field device electrical circuits shall be designed to be 'Fail Safe' such that the field device contact status wiring shall be in a 'closed' state during normal operation and the device and circuit changes to an 'open' state indicative of an alarm (or abnormal) condition.

2-4. SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS. The equipment provided for the instrumentation and control system shall be suitable for the service conditions specified in the attached equipment sections.

All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.

2-4.01. Ambient Temperature and Elevation. All system equipment located in air conditioned rooms shall be suitable for operation in ambient temperatures from 10°C to 35°C and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non-air conditioned indoor areas shall be suitable for an ambient temperature range of 0°C to 50°C and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range -20°C to 60°C and a relative humidity of 5 to 100 percent. Heaters and air

conditioning/cooling equipment shall be provided where essential to maintain equipment within its manufacturer-recommended operating ranges.

All equipment and instruments shall be designed to operate at the site elevation of 1100 ft.

2-4.02. Deleterious Effects. All system equipment will be installed in areas without anti-static floor construction and without any provisions for control of particulates or corrosive gases other than ordinary office-type HVAC filtering. System Supplier shall furnish any additional air cleaning equipment, anti-static chair pads, or other protective measures necessary for proper operation of the system.

All input/output hardware shall meet or exceed, without false operation, all requirements of NEMA ICS-1-109.60, Electrical Noise Tests.

2-4.03. Noise Level. The equivalent "A" weighted sound level for any system equipment located in the control room, except printers, shall not exceed 35 dBA. The sound level for printers shall not exceed 65 dBA. Sound reduction enclosures shall be provided where necessary to comply with these limits.

2-4.04. Lightning Protection. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.

2-4.04.01. Grounding. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the Drawings shall be modified as recommended by System Supplier.

2-4.04.02. Surge Suppressors. Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) or silicon junction type, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:

All 120 VAC power connections to RTUs, PLCs, DCUs, instruments and control room equipment. Surge arresters shall be Transtector "ACP-100-HW Series", Power Integrity Corporation “ZTA Series”, Phoenix Contact “Mains PlugTrab”, or MCG Surge Protection “400 Series”.

All connections to coaxial-based networked equipment (including CCTV, CATV, Ethernet, Arcnet, and satellite) where any part of the circuit is outside of the building envelope. Surge arresters shall be Telematic “VP08”, Transtector CCTV-PTZ Series”, Phoenix Contact “CoaxTrab Series”, or Northern Technologies “TCS-CP3 Series”.

All analog signal circuits where any part of the circuit is outside of the building envelope.

Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede or interfere with the use of smart transmitter calibration/communication. Protection devices located near the transmitter shall be Telematic "TP48." Protection devices in control panels shall be Transtector "PDS Series or FSP Series", Telematic "SD Series", Phoenix Contact "PipeTrab Series", or Citel "BP1-24."

All metallic pair (twisted and untwisted) conductor local area network and data highway termination points, where any part of the data highway cable is routed outside of the building envelope. Single-port protective devices shall be Phoenix Contact "PlugTrab Series", Transtector "FSP" Series", or Telematic "NP Series."

All serial, PLC data highway, and remote I/O network termination points where any part of the circuit is routed outside of the building envelope. Surge protection devices shall be Transtector "DRDC Series" (RS-232); Transtector "FSP Series" (RS-422), Phoenix Contact "PlugTrab Series" or Citel "E280 Series".

2-4.05 Instrument Mounting

Mount and install equipment as indicated on drawings. Where not shown, mount field instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with supplier's recommendation. Where mounted in control panels, mount according to manufacturer recommendations.

Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting. Non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than three (3) feet nor higher than five (5) feet above walkways, platforms, catwalks, etc. All such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in NEMA 4X cases unless otherwise noted.

2-4.06 Instrument Identification

All components provided under this section, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

Nameplates for panels and panel mounted equipment shall be as specified under Section 17570, Panels.

Field mounted tags shall be 16-gauge, 304 stainless steel with 3/16 inch high characters.

Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with standard stainless steel hose clamps and meeting the same description. In some cases where this would be impractical, use 20 gage stainless steel wire.

For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In all cases the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

2-5. SOFTWARE DOCUMENTATION. System Supplier shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the optical media backup. Software documentation shall consist of the following principal items.

a. One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.

b. Two complete back-up copies of system and application software in executable format on optical media compatible with the system furnished.

c. Three sets of user reference manuals for all standard system and application software.

d. One set of user reference manuals for all operating system software.

e. Three sets of printed as-built reference documentation for any special software provided specifically for this contract.

f. For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. One set of this documentation shall be supplied for each and every piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2-6. SOFTWARE LICENSE. All software programs supplied as a standard part of System Supplier's products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict Owner from using the software on the system provided hereunder or its replacement. Owner shall have the right to make copies of the software for use on the system provided. Specific requirements of System Supplier's software license are subject to review and approval by Owner and Engineer.

2-7. INSTALLATION TEST EQUIPMENT. All necessary testing equipment for calibration and checking of system components shall be provided by System Supplier.

System Supplier shall also furnish calibration and maintenance records for all testing and calibration equipment used on the site if requested by Engineer.

2-8. PROGRAMMING DEVICES. The following programming devices shall be provided for the instruments specified in other sections. The quantity required may be combined where the same programming device can be utilized for different instrument types:

Instruments Requiring Programming Devices	Quantity of Programming Devices
Panel mounted instruments	One (1)
Flow instruments	One (1)
Pressure and level instruments	One (1)
Analytical instruments	One (1)
Miscellaneous instruments	One (1)

2-9. PROGRAMMING SOFTWARE. The following programming software shall be provided for the instruments specified in other sections. The quantity required may be combined where the same programming software can be utilized for different instrument types:

Instruments Requiring Programming Software	Number of Copies of Programming Software
Panel mounted instruments	One (1)
Flow instruments	One (1)
Pressure and level instruments	One (1)
Analytical instruments	One (1)
Miscellaneous instruments	One (1)

PART 3 – EXECUTION

3-1. INSTALLATION REQUIREMENTS. The installation of equipment furnished hereunder shall be by the Contractor or their assigned subcontractors.

3-1.01. Field Wiring. Field wiring materials and installation shall be in accordance with the electrical section.

3-1.02. Instrument Installation. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the Drawings.

All outdoor instrumentation shall be protected from direct sun exposure. Instruments shall be placed in locations to limit south and west sun exposure. Sunshades shall be provided on instruments that are subject to the direct sun exposure. Sunshades shall be located so the opening faces north or east where possible. Sunshades shall be provided as shown on the Drawings.

3-1.03. Salvage of Existing Equipment. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner, or shall be properly disposed of at Owner's discretion. Care shall be taken to avoid damage to equipment delivered to Owner.

Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer. Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3-2. SYSTEM SOFTWARE CONFIGURATION. System software shall be configured by the System Supplier. Configuration services shall consist of the expansion of the existing system database, new report formats, additional operator interface graphic and tabular display screen formats, additional password and security implementation needed, and programming of control units to provide a fully functioning system. The System Supplier shall fully configure the system using data provided herein or supplied by the Engineer and/or the Owner after award of the contract.

3-2.01. Control System Database. The control system database shall be expanded and configured by the System Supplier. The System Supplier shall not enter information obtainable from the Contract Documents into the database prior to soliciting input from the Engineer and the Owner. The System Supplier shall determine the need for any "pseudo" database points and shall ascertain and enter all information needed to define these points. The System Supplier is responsible for entering all information associated with each point. This includes but is not limited to, descriptions, engineering units, associated displays, areas, security, etc. All fields associated with each database point must be completely filled out accurately.

3-2.02. Graphic Screen Displays. The System Supplier shall be responsible for developing and configuring the new custom graphic displays and modifying existing plant process displays and menus as required. Each piece of major process equipment that is monitored by the control system shall be displayed on one or more graphic screen. Graphic screens shall be representations of the equipment and piping. The

screens must accurately show all devices and equipment that is part of the control loops. These items must be done in accordance to the Configuration Standards and Conventions as described later in this section. Alarm and/or event displays shall also be provided and proven functional prior to acceptance of the system. A means of capturing and printing of all graphic screens shall also be included. The software program provided must be capable of printing the screen in a black and white (using gray scale) or color format. This program must be accessible from all terminals provided under this contract. The black and white printing shall be done in a manner in which the use of the black background is not represented in the printout. This is done to keep the utilization of ink cartridge and toner cartridge to a minimum.

All graphic screens shall be animated to indicate the current state of the piece of equipment. The following graphic screens shall be modified (or provided new), as a minimum.

- Main Overview of Plant
- Alarm Summary
- Event Summary
- Overview of each major process area (with vectoring to sub-areas)
- Process Loop Details (including real-time trending and loop tuning parameters for field adjustments)
- Summary screen to vector to all video trends

A minimum of twelve (12) new custom graphic displays shall be provided by the System Supplier in addition to modifications required to existing system displays and menus.

3-2.03. Report Formats. Existing report formats shall be modified as required by OWNER and programmed by the System Supplier using tag names defined in the database expansion. Existing reports shall be reviewed by System Supplier and OWNER to determine what data shall be removed and additional data added to reports. All reports will be provided with a header on each page to indicate the contents of each column of information. Each page shall be numbered and indicate the name of the report, the date the report was printed, and the time of the printout. The printout shall also include the time span of the information shown on the report.

- Daily Operating Report.
- Monthly Operating Report.

3-2.04. Configuration Standards and Conventions. A “Software Configuration Standards and Conventions” document shall be prepared and submitted by the System Supplier. The document shall be submitted for review and approval before software configuration commences. The document shall describe and define such items as proposed graphic display process line colors/representations; symbology; color standards for “on”, “off”, “opened”, “closed”, and “alarm” conditions; alarm handling

conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Before submitting the initial draft document, the System Supplier shall meet with the Engineer and Owner to review any of the Owner's existing standards and conventions. All copies of this submittal shall be provided in color to insure the accuracy of each item. No black and white copies will be accepted. The colors used in the printed submittal shall accurately depict the colors and shapes proposed for use on the final system.

In addition to submitting the document for review, an updated version of the document shall be submitted as part of the O&M Manuals. The document shall be revised to document any additional standards that are established throughout the configuration process.

3-2.05. Configuration Review Meetings. Proposed graphic screens and report formats shall be reviewed with the Owner and Engineer throughout the configuration process. The System Supplier's programming personnel shall attend all meetings. A second review meeting shall be held at approximately 50 percent completion. Both meetings shall be held at the Owner's facilities.

3-2.06. Software Functional Requirements. General functional requirements for system configuration are indicated on the Drawings and described in the specifications. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system, and may not be sufficient to fully configure the system. The System Supplier shall be responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Engineer or the Owner.

3-3. SYSTEMS CHECK. System Supplier shall provide the services of a field manager and a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

3-3.01. Field Manager. System Supplier shall appoint a field services manager who shall be responsible for the coordination of all system check-out and startup activities, and who shall be immediately available to Engineer and Owner by phone or on site for the duration of this project.

3-3.02. Field Inspection at Delivery. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

3-3.03. Field Calibration of Instruments. After each instrument has been installed, a technical representative of System Supplier shall calibrate each instrument and shall

provide a written calibration report for each instrument, indicating the results and final settings. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage tampering. Instrument calibration shall be done before checkout of the system operation. A typical instrument calibration report is attached to the end of this section.

3-3.04. Training for Installation Personnel. The field supervisor shall train the installation personnel in reading and understanding submittal drawings, and in the correct installation and wiring procedures for the equipment. Three (3) days shall be included for this training to cover all working shifts of Owner personnel.

3-3.05. Field Inspection Prior to Start Up. After installation and wiring connections are complete, the field supervisor, with additional System Supplier's personnel shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended. A minimum of five (5) working days shall be included for this task, but System Supplier shall be responsible for completing the following scope of work.

3-3.05.01. Analog Signals. Analog input signals shall be simulated at the transmitting source, and verified to be received at the proper data address / tagname in the control system. Analog outputs shall be generated using appropriate instrument configuration tools (where feasible) at the control system, and verified to be received with the correct polarity, at the respective receiving device. Correct display of data and engineering units shall be verified on all applicable HMI / graphics displays.

3-3.05.02. Discrete Signals. Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device at the proper voltage and at the proper data address / tagname in the control system. Where feasible, actuation of the field device connected shall be used to verify the signal. Correct display of data and engineering description shall be verified on all applicable HMI / graphics displays.

3-3.05.03. Devices by Other Suppliers. If interrelated devices furnished by other suppliers, under other contracts, or by Owner, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

3-3.05.04. System Check Out Report. Upon completion of all testing, the System Supplier shall submit a written certified report on the results of such tests to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. System Supplier and Contractor shall verify, in writing, to Engineer and Owner that System Supplier, Contractor, and all sub-

contractors have successfully completed the external connection check before beginning system startup or field acceptance testing.

Certified report shall be provided for each control panel and associated field instruments certifying the equipment (1) had been properly installed under his supervision, (2) is in accurate calibration, (3) was placed in operation in his presence, (4) has been checked, inspected, and adjusted as necessary, (5) has been operated under maximum power variation conditions and operated satisfactorily, and (6) is fully covered under the terms of the guarantee.

3-3.06. Start Up Assistance. After the field supervisor has completed the system check and submitted his report, System Supplier shall supply a factory-trained engineer and programmer to provide on-site start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components. Fifteen (15) working days shall be included for this task.

3-4. TESTING. The system shall be acceptance tested at the factory and on site.

System Supplier shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by System Supplier and witnessed by Owner and Engineer.

System Supplier shall notify Engineer and Owner in writing at least 14 days before the proposed testing date. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. System Supplier shall reimburse Owner and Engineer for all expenses (travel & living) incurred in connection with attending factory and site testing.

3-4.01. Factory Acceptance Testing (FAT). After system assembly and debugging at System Supplier's facility, the system shall be tested (unwitnessed and witnessed) before the system is shipped to the site. The factory test shall be conducted on a complete (duplicate) host computer system incorporating the database expansion of the ICWRC DCS, including all new field I/O devices, communications and network equipment, and peripherals. The FAT host computer configuration shall consist (at a minimum) of one (1) DCS server computer, one (1) DCS operator workstation, all Foxboro DCS application software, printer, and PLC programming station (computer or laptop) and new PLC-based systems.

The procedures for testing multiple equipment supplier furnished PLC-based control systems shall be reviewed and approved by OWNER and Engineer as part of the testing procedure submittals noted above.

The System Supplier shall be responsible for providing all application software required and computer equipment required for both unwitnessed and witnessed FAT including necessary PCS software development licenses.

The System Supplier shall complete and submit results of unwitnessed FAT to OWNER and Engineer at least seven (7) days prior witnessed FAT. OWNER & Engineer acceptance of the unwitnessed FAT results shall be a prerequisite to witnessed FAT. A Configuration report shall be included with the results of the unwitnessed FAT verifying the model and serial number of all major component(s) used in FAT.

The entire system, including all peripherals and associated software, shall be factory tested under simulated operating conditions. Both normal operating sequences and fault conditions shall be simulated. The results shall be noted in the HMI alarm/event log. The testing procedures for hardware and software are described below.
All basic functions shall be demonstrated, including I/O processing, communications, alarm handling, HMI display functions, alarm logging, report generation, and historical data storage, as well as the specific functions listed herein. The system shall operate continuously for at least a 72 hours without faults. This operational test may run concurrently with the demonstration of hardware and software functions. The test procedure shall also include at a least four-hour period for discretionary tests to be conducted by Engineer or Owner.

3-4.01.01. Hardware Test. Processors, processor modules, and peripheral devices associated with the system shall be assembled together as they will be installed in the field and shall be tested. The test shall demonstrate proper operation of each hardware device and communications among devices, and shall include verification of selected analog and discrete inputs and outputs.

3-4.01.02. Software Test. All system software modules specified herein shall be demonstrated. Software tests shall include running all diagnostics, debugging routines, and system test routines. The operating system, advanced process control language compiler, and all associated drivers shall be fully tested and operable for the system test. Software "patches" or changes to bypass failed or flawed modules during the test will not be acceptable.

3-4.02. Site Acceptance Testing. After installation and checkout by System Supplier's personnel, the system shall be subjected to an acceptance test.

Site acceptance testing shall be scheduled after receipt of the System Check-Out Report and System Supplier shall verify that all field signal changes are reflected in the proper address locations in the system database.

The site acceptance testing shall follow the same procedure as the factory testing and shall operate without loss of basic functions. The number of working days of continuous

operation for the test shall be five (5). The operational demonstration shall confirm that the status, alarm, and process variable signals are valid and are being updated appropriately, and that the discrete and analog output signals from the control system are being correctly transmitted and implemented. Any errors or abnormal occurrences shall be recorded by System Supplier's field representative. System Supplier's field representative need not be continuously present during the site acceptance testing, but shall be available to respond to the site within one hour of notification. The representative shall inspect the system for faults at least once every 24 hours and shall log or record any noted problems. The log shall include a description of the problem, its apparent cause, and any corrective action taken.

3-4.02.01. Failure of Redundant Equipment. Failure of redundant equipment shall not be considered downtime provided that automatic failover occurs as specified and, in the opinion of Engineer, the failure was not caused by deficiency in design or installation. In the event of repeated failure of any hardware component or software module, the acceptance test shall be terminated and re-started.

3-4.02.02. Completion of Test. Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the Supplementary Conditions.

3-5. TRAINING. System Supplier shall conduct training courses for personnel selected by Owner. Training shall be provided in the following categories: instrument, control system maintenance, operator (pre-installation), operator (post-installation), programmer (HMI software), programmer (PLC software), networking, and supplemental shall be provided. Training shall be conducted by experienced instructors who are familiar with the specific system supplied.

3-5.01. General Training Requirements. In general, System Supplier's standard training courses may be used to meet the training objectives specified. Where standard courses do not meet these objectives, additional coursework shall be developed. Clock hour requirements for each level of training are shall be as listed. A "clock hour" is defined as one hour of instruction or supervised training exercise. Training hour requirements are the number of hours of training to be provided for each student. Additional training time shall be provided if considered necessary to meet the training objectives.

3-5.01.01. Training Costs. All costs associated with the training program; including travel, lodging, and per diem expenses for Owner's and Engineer's personnel to attend off-site training programs; shall be the responsibility of System Supplier and shall be included in the contract price.

3-5.01.02. Lessons. Training lesson plans and other information for the second stage submittal as defined herein shall be submitted at least 30 days prior to the start of training.

3-5.01.03. Video Recording. All training sessions shall be video recorded by the System Supplier for Owner's future use in training other personnel. Video recorded sessions shall be saved to DVD/R media for delivery to Owner. Pre-recorded videos of System Supplier's standard training programs may be substituted if they cover the same topics and are developed for the same versions of hardware and software. Furnishing videos of standard training programs shall not relieve System Supplier from any of the training requirements specified herein.

3-5.02. Instrument Training. Training on the calibration, maintenance, troubleshooting, and repair for the instrument devices provided under this project shall be provided. Training shall also be provided for any hand-held or computer-based calibration devices and their associated software. Twenty-four (24) hours of training for six (6) students (3 - 8 hour sessions each with 2 students per working shift) shall be provided at the Owner's facility.

3-5.03. Control System Maintenance Training. Not used.

3-5.04. Operator Training. Owner's personnel will utilize the system for day-to-day monitoring and/or control of the facilities. The training program shall provide operators with sufficient knowledge to move from screen to screen within the system, understand the contents of group and detailed point displays, react to and acknowledge alarms, adjust control set-points and alarm limits, configure and print shift reports, print preconfigured reports on demand, control equipment connected to the system, and react to and resolve minor system errors.

3-5.04.01. Classes. Operator training shall include sessions as specified below.

3-5.04.01.01. Pre-installation Session. Each pre-installation training session shall consist of eight (8) hours of training for three (3) students at the Owner's facility. Three (3) 8 hour sessions shall be scheduled to provide training for all working shifts.

3-5.04.01.02. Post-installation Session. The post-installation training shall include three separate, but identical, sessions for three shifts of personnel and shall be conducted at Owner's facilities. Each class shall consist of two (2) days (sixteen (16) hours) of instruction using the lesson plan submitted and approved for use. The post-installation sessions may have to be conducted outside normal working hours to accommodate the working schedule of Owner's personnel. The post-installation training sessions shall be conducted for ten (10) of the Owner's operating personnel.

3-5.04.02. Content of Classes. Each session shall cover at least the following topics.

a. Power-up, "bootstrapping", and shutdown of all hardware devices.

b. Logging on and off the system and the use of passwords.

c. Access and interpretation of standard displays and diagnostics.

d. Use and care of operator workstations, servers, video displays, printers, and other control room hardware, including replenishment of supplies and replacement of ribbons and ink cartridges.

e. Moving from screen to screen within the graphic display environment.

f. Interpretation of preconfigured group and detailed point or database displays.

g. Operator response and acknowledgment of alarms.

h. Adjustment of control set points and alarm limits.

i. Configuration and printing of shift and other reports by schedule or on demand.

j. Control of field equipment and devices connected to the system.

k. Manual entries to database points.

l. Generation of current (real-time) and historical custom and predefined reports and trend displays.

m. Appropriate responses to software and hardware errors.

n. Enabling and disabling individual inputs and outputs.

The operator-training program shall be developed for personnel with no prior experience with the hardware and software provided as part of the project.

3-5.05. Programmer Training (HMI Software). Programmer training shall be furnished as described in this section.

System programming training shall be provided to enable Owner's personnel to initially configure and later reconfigure the system. Programming tasks shall include addition or modification to the system database; modification or creation of graphic and tabular display and report formats; and creation and modification of historical archiving groups and data reduction algorithms.

3-5.05.01. Classes. Programmer training shall be conducted in two sessions. The first session shall consist of eight (8) hours of instruction for three (3) students and shall be conducted at Owner's facilities within 30 days of delivery of the configuration hardware and software. The second session shall consist of eight (8) hours of instruction for three (3) students and shall be conducted at Owner's facility.

3-5.05.02. Content of Classes. Programmer training shall include, but shall not be limited to the following topics:

a. Loading of any supplied software into the system.

b. Use of basic operating system commands for file management, system startup, and creation and editing of batch files.

c. Creation and editing of database.

d. Configuration of printed report formats.

e. Creation and editing of tabular and graphic HMI interface display screens.

f. Diagnostic routines.

g. Creation and modification of control algorithms.

h. Addition of new I/O points and new RTUs, PLCs or DCUs to the system.

i. Historical record retrieval, data reduction, archiving, and disk housekeeping.

j. System backup procedures and reloading from backup.

Programmer training shall be designed for personnel who have a general familiarity with control system operation and high-level application programs, but not necessarily with the specific hardware or software furnished for this project.

3-5.05.03. Hardware and Software. The first session of training shall be conducted using hardware and software of the same versions as provided for the system specified. Programmer training for the second session shall be conducted using equipment and software installed at the site.

3-5.06. Programmer Training (PLC Software). Programmer training shall be provided for the PLC software furnished. Programmer training shall be provided on at least the following topics.

a. File management and backup procedures.

b. Documentation printing options.

c. Entering I/O and database points.

d. Logic function programming.

e. PID loop programming and tuning.

f. Error recovery and interpretation of errors.

g. Communication protocol set-up and diagnostics.

PLC software programmer training shall be conducted at Owner's facilities within 30 days of delivery of PLC's. The training shall consist of twenty-four (24) hours (3 – 8 hour days) of instruction for three (3) students.

3-5.07. Network Training. Not used

3-5.08. Supplemental Training. System Supplier shall provide additional training to Owner's personnel on topics of Owner's choosing. Supplemental training shall be conducted over a 2-day period at Owner's facilities using the hardware and software installed for this project. The training shall consist of sixteen (16) hours of instruction for five (5) students.

3-6. GUARANTEE AND WARRANTEES. Guarantee all work of Division 17 in accordance with the Conditions of Contract and Division 1. With respect to instruments and equipment, guarantee shall cover (a) faulty or inadequate design; (b) improper assembly or erection; (c) defective workmanship or materials; and (d) leakage, breakage, or other failure not caused by City misuse. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty to Engineer with City named as beneficiary.

End of Section

INSTRUMENT NAME & SERVICE:		
BRAND & MODEL NO.:		
TAG OR LOOP NO.:		
INPUT/OUTPUT RANGE:		
INPUT	ACTUAL OUTPUT	DESIRED OUTPUT
PROPORTIONAL BAND:		
RESET:		
POSITION OF SWITCHES, JUMPERS, ETC.		
COMMENTS:		
DATE OF CALIBRATION: CALIBRATED BY:		
Black & Veatch	INSTRUMENT CALIBRATION REPORT	Figure 1-17500

17500-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM:

Loop No.:_____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

	Continuity Resistance [a]	Insulation Resistance [b]				
Wire No.	Panel Tie	Field TB	Cond./ Cond.	Shield/ Shield	Cond./ Gnd.	Shield/ Gnd.
A		--	(A/SH)			
B		(A/B)	--			
C		(A/C)	--			
D		(A/D)	--			
etc.						

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-B. CONTROL CIRCUIT PIPING LEAK TEST FORM:

Loop No.:_____

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

Tube No.	Tubing Equivalent Length of 1/4-Inch Copper[a]	Permitted Pressure Test Period (seconds)	Measured Pressure Drop (psi)[b]	Drop (psi)
A				
B				
C				
D				
etc.				

a. Convert actual tubing and air motor volume to equivalent 1/4-inch copper tubing.

b. Pressure drop shall not exceed 1 psi per hundred feet 1/4-inch tubing per 5 seconds.

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-C. CONTROLLER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

% of Range	Expected Input	Actual Reading	Reading	% Deviation
0				
50				
100				

% Deviation Allowed: _____

Connect output to PV for following tests:

	Set Point (SP) Indicator Accuracy			Output Meter Accuracy		Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Reading	Expected Reading	Actual % Dev. Dev.	Output	Output	%
(0%)		0%						
(50%)		50%						
(100%)		100%						
% Dev. Allowed:		% Dev. Allowed:		% Dev. Allowed:				

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-D. PANEL INDICATOR CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input:

Scale: _____ Range: _____

PV Scale Calibration

% of Range	Expected Input	Actual Reading	Reading	% Deviation
0				
50				
100				

% Deviation Allowed: _____

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-E. RECORDER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____ Chart: _____

Scale: _____ Range: _____

% of Range	Expected Input	Actual Scale Reading	Scale Reading	% Deviation
0				
50				
100				

% Deviation Allowed: _____

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-F. SIGNAL TRIP CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input:

Scale: _____ Range: _____

Set Point(s): _____

After setting set point(s), run signal input through entire range and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-G. FIELD SWITCH CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

17500-H. TRANSMITTER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Expected Input	Expected Output	Actual Output	% Deviation
0				
50				
100				

% Deviation Allowed: _____

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM:

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

17500-J. INDIVIDUAL LOOP TEST DATA FORM:

Loop No.:

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:
(Attach test form 17500-A)

b. Instrumentation tubing/piping tested:
(Attach test form 17500-B)

c. Instruments calibrated:
(Attach test forms 17500-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Engineer's approval.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

17500-K. LOOP COMMISSIONING TEST DATA FORM:

Loop No.: _____

a. Loop tested:
(Attach test form 17500-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

Instrument Device Schedule - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only.
Building Code. This refers to the associated plant.
Tag. This is the ISA (or similar) alpha tag representing the function of the instrument.
System Code. This is the abbrevation for each process. (refer to legend sheets)
Service Description. This is the description of the instrument service (refer to legend sheets).
Device Type & Size. This is the instrument device type and should match the description as listed in the specification. Where appropriate, the size of the device (such as diameter of flowmeters) will be listed.
Output Type. This generally will be '4-20 mA' or "Dry Contact'. It could also be a serial output for smart devices (such as HART or FLD-BUS) but only if the serial output is the primary I/O interface.
Output Range. This is the calibrated range for analog devices or the trip point(s) for discrete devices.
Power Type. This will typically be either '2-wire' for loop powered devices or '4-wire' for 120 volt powered devices.
Install Detail. This is a reference to the installation detail on the drawings if applicable.
P&ID Drawing. This is the drawing number of the P&ID where the device is shown.
Spec. This column may include a cross reference to another specification section where applicable or to a note which provides additional information. Notes are appended to the end of the device schedule listings.

Sr.No	Building Code	System Code	Tag	Loop	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID	Specification	Remarks
1	B	PRC	LSH	10	CLARIFIER INFLUENT JUNCTION BOX HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IB001	17563	
2	B	PRC	LE	10	PRIMARY CLARIFIER NO. 1 SLUDGE BLANKET LEVEL SENSOR	SLUDGE BLANKET LEVEL SENSOR	NA		NA	NA	IB002	17563	EXISTING
3	B	PRC	LIT	10	PRIMARY CLARIFIER NO. 1 SLUDGE BLANKET LEVEL TRANSMITTER	SLUDGE BLANKET TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IB002	17563	EXISTING
4	B	PRC	LE	20	PRIMARY CLARIFIER NO. 2 SLUDGE BLANKET LEVEL SENSOR	SLUDGE BLANKET LEVEL SENSOR	NA		NA	NA	IB002	17563	
5	B	PRC	LIT	20	PRIMARY CLARIFIER NO. 2 SLUDGE BLANKET LEVEL TRANSMITTER	SLUDGE BLANKET TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IB002	17563	
6	B	PRC	LE	30	PRIMARY CLARIFIER NO. 3 SLUDGE BLANKET LEVEL SENSOR	SLUDGE BLANKET LEVEL SENSOR	NA		NA	NA	IB003	17563	
7	B	PRC	LIT	30	PRIMARY CLARIFIER NO. 3 SLUDGE BLANKET LEVEL TRANSMITTER	SLUDGE BLANKET TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IB003	17563	
8	B	PRC	LE	40	PRIMARY CLARIFIER NO. 4 SLUDGE BLANKET LEVEL SENSOR	SLUDGE BLANKET LEVEL SENSOR	NA		NA	NA	IB003	17563	ADDITIVE ALTERNATIVE
9	B	PRC	LIT	40	PRIMARY CLARIFIER NO. 4 SLUDGE BLANKET LEVEL TRANSMITTER	SLUDGE BLANKET TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IB003	17563	ADDITIVE ALTERNATIVE
10	B	PSC	LSH	10	SCUM WELL NO. 1 HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IB004	17563	
11	B	PSC	LSHH	10	SCUM WELL NO. 1 HIGH HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IB004	17563	
12	B	PSC	LSLL	10	SCUM WELL NO. 1 LOW LOW LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IB004	17563	
13	B	PSC	TSH	10	SCUM PUMP NO. 1 HIGH MOTOR TEMP. SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
14	B	PSC	LSL	10	SCUM PUMP NO. 1 HIGH MOTOR LOW OIL LEVEL SWITCH	LEVEL SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
15	B	PSC	TSH	20	SCUM PUMP NO. 2 HIGH MOTOR TEMP. SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
16	B	PSC	LSL	20	SCUM PUMP NO. 2 HIGH MOTOR LOW OIL LEVEL SWITCH	LEVEL SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
17	B	PSC	LSH	20	SCUM WELL NO. 2 HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IB004	17563	
18	B	PSC	LSHH	20	SCUM WELL NO. 2 HIGH HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IB004	17563	
19	B	PSC	LSLL	20	SCUM WELL NO. 2 LOW LOW LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IB004	17563	
20	B	PSC	LSL	30	SCUM PUMP NO. 3 HIGH MOTOR LOW OIL LEVEL SWITCH	LEVEL SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
21	B	PSC	TSH	30	SCUM PUMP NO. 3 HIGH MOTOR TEMP. SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
22	B	PSC	LSL	40	SCUM PUMP NO. 4 HIGH MOTOR LOW OIL LEVEL SWITCH	LEVEL SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
23	B	PSC	TSH	40	SCUM PUMP NO. 4 HIGH MOTOR TEMP. SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IB004		
24	B	PRC	FE	30	FROM ICWRC TPS TO INFLUENT JUNCTION BOX FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	36 INCH	NA	NA	NA	IB005	17562	
25	B	PRC	FIT	30	FROM ICWRC TPS TO INFLUENT JUNCTION BOX FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IB005	17562	
26	B	PRC	FE	40	FROM SWRC PRELIMINARY TREATMENT BDG FLOW SENSOR 1	ELECTROMAGNETIC FLOW SENSOR	48 INCH	NA	NA	NA	IB005	17562	
27	B	PRC	FIT	40	FROM SWRC PRELIMINARY TREATMENT BDG FLOW TRANSMITTER 1	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IB005	17562	
28	B	PRC	FE	50	FROM SWRC PRELIMINARY TREATMENT BDG FLOW SENSOR 2	ELECTROMAGNETIC FLOW SENSOR	48 INCH	NA	NA	NA	IB005	17562	
29	B	PRC	FIT	50	FROM SWRC PRELIMINARY TREATMENT BDG FLOW TRANSMITTER 2	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IB005	17562	
30	C	FECL	LE	100	FERRIC CHLORIDE STORAGE TANK NO. 1 LEVEL SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IC007	17563	
31	C	FECL	LE	200	FERRIC CHLORIDE STORAGE TANK NO. 2 LEVEL SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IC007	17563	
32	C	FECL	LIT	100	FERRIC CHLORIDE STORAGE TANK NO. 1 LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4-WIRE	IC007	17563	
33	C	FECL	LIT	200	FERRIC CHLORIDE STORAGE TANK NO. 2 LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4-WIRE	IC007	17563	
34	C	FECL	PI	100	FERRIC CHLORIDE PUMP NO. 1 INLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
35	C	FECL	LSH	100	FERRIC CHLORIDE PUMP NO. 1 LEAK SWITCH	LEAK SWITCH		DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IC009		
36	C	FECL	PI	101	FERRIC CHLORIDE PUMP NO. 1 OUTLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
37	C	FECL	PI	102	FERRIC CHLORIDE PUMP NO. 1 OUTLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
38	C	FECL	PSH	100	FERRIC CHLORIDE PUMP NO. 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IC009	17563	
39	C	FECL	PI	200	FERRIC CHLORIDE PUMP NO. 2 INLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
40	C	FECL	LSH	200	FERRIC CHLORIDE PUMP NO. 2 LEAK SWITCH	LEAK SWITCH		DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IC009		
41	C	FECL	PI	201	FERRIC CHLORIDE PUMP NO. 2 OUTLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
42	C	FECL	PI	202	FERRIC CHLORIDE PUMP NO. 2 OUTLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
43	C	FECL	PSH	200	FERRIC CHLORIDE PUMP NO. 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IC009	17563	
44	C	FECL	PI	300	FERRIC CHLORIDE PUMP NO. 3 INLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
45	C	FECL	LSH	300	FERRIC CHLORIDE PUMP NO. 3 LEAK SWITCH	LEAK SWITCH		DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IC009		
46	C	FECL	PI	301	FERRIC CHLORIDE PUMP NO. 3 OUTLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	

Sr.No	Building Code	System Code	Tag	Loop	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID	Specification	Remarks
47	C	FECL	PI	302	FERRIC CHLORIDE PUMP NO. 3 OUTLET PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IC009	17563	
48	C	FECL	PSH	300	FERRIC CHLORIDE PUMP NO. 3 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IC009	17563	
49	C	FECL	FE	100	FERRIC CHLORIDE PUMP NO. 1 FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	1 INCH	NA	NA	NA	IC009	17562	
50	C	FECL	FIT	100	FERRIC CHLORIDE PUMP NO. 1 FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IC009	17562	
51	C	FECL	FE	200	FERRIC CHLORIDE PUMP NO. 2 FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	1 INCH	NA	NA	NA	IC009	17562	
52	C	FECL	FIT	200	FERRIC CHLORIDE PUMP NO. 2 FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IC009	17562	
53	C	FECL	FE	300	FERRIC CHLORIDE PUMP NO. 3 FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	1 INCH	NA	NA	NA	IC009	17562	
54	C	FECL	FIT	300	FERRIC CHLORIDE PUMP NO. 3 FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IC009	17562	
55	F	EQB	LE	10-1	EQUILIZATION TANK NO. 1 LEVEL SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IF003	17563	
56	F	EQB	LIT	10-1	EQUILIZATION TANK NO. 1 LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IF003	17563	
57	F	EQB	LE	10-2	EQUILIZATION TANK NO. 1 LEVEL SENSOR (BACK UP)	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IF003	17563	
58	F	EQB	LIT	10-2	EQUILIZATION TANK NO. 1 LEVEL TRANSMITTER (BACK UP)	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IF003	17563	
59	F	EQB	LE	10-3	EQUILIZATION TANK NO. 2 LEVEL SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IF003	17563	ADDITIVE ALTERNATIVE
60	F	EQB	LIT	10-3	EQUILIZATION TANK NO. 2 LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IF003	17563	ADDITIVE ALTERNATIVE
61	F	EQB	LE	10-4	EQUILIZATION TANK NO. 2 LEVEL SENSOR (BACK UP)	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IF003	17563	ADDITIVE ALTERNATIVE
62	F	EQB	LIT	10-4	EQUILIZATION TANK NO. 2 LEVEL TRANSMITTER (BACK UP)	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IF003	17563	ADDITIVE ALTERNATIVE
63	F	EQB	PIT	10	EQUILIZATION TANKS INLET PRESSURE TRANSMITTER	PRESSURE TRANSMITTER	NA	4-20 mA DC	0 - XX PSI	2-WIRE	IF003	17563	
64	H	SCR	LE	10A	COARSE SCREEN NO. 1 DIFFERENTIAL LEVEL UPSTEAM SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IH002	17563	
65	H	SCR	LE	10B	COARSE SCREEN NO. 1 DIFFERENTIAL LEVEL DOWNSTREAM SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IH002	17563	
66	H	SCR	LDIT	10	COARSE SCREEN NO. 1 DIFFERENTIAL LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	2-WIRE	IH002	17563	
67	H	SCR	WS	10	COARSE SCREEN NO. 1 HOME POSITION SWITCH	PROXIMITY SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IH002		
68	H	SCR	WS	11	COARSE SCREEN NO. 1 MOTOR HIGH TORQUE SWITCH	TORQUE LIMIT SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IH002		
69	H	SCR	LSH	10	COARSE SCREEN NO. 1 UPSTREAM HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IH002	17563	
70	H	SCR	LE	20A	COARSE SCREEN NO. 2 DIFFERENTIAL LEVEL UPSTEAM SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IH003	17563	
71	H	SCR	LE	20B	COARSE SCREEN NO. 2 DIFFERENTIAL LEVEL DOWNSTREAM SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IH003	17563	
72	H	SCR	LDIT	20	COARSE SCREEN NO. 2 DIFFERENTIAL LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	2-WIRE	IH003	17563	
73	H	SCR	WS	20	COARSE SCREEN NO. 2 HOME POSITION SWITCH	PROXIMITY SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IH003		
74	H	SCR	WS	21	COARSE SCREEN NO. 2 MOTOR HIGH TORQUE SWITCH	TORQUE LIMIT SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IH003		
75	H	SCR	LSH	20	COARSE SCREEN NO. 2 UPSTREAM HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IH003	17563	
76	P	RPS	LE	30	TRANSFER PUMP STATION LEVEL SENSOR	ULTRASONIC LEVEL SENSOR	NA		NA	NA	IP001	17563	
77	P	RPS	LIT	30	TRANSFER PUMP STATION LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IP001	17563	
78	P	RPS	LSH	31	TRANSFER PUMP STATION HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IP001	17563	
79	P	RPS	LSL	32	TRANSFER PUMP STATION LOW LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IP001	17563	
80	P	RPS	MSH	10	TRANSFER PUMP NO. 1 MOISTURE SWITCH	MOISTURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
81	P	RPS	TSH	10	TRANSFER PUMP NO. 1 HIGH TEMPERATURE SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
82	P	RPS	MSH	20	TRANSFER PUMP NO. 2 MOISTURE SWITCH	MOISTURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
83	P	RPS	TSH	20	TRANSFER PUMP NO. 2 HIGH TEMPERATURE SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
84	P	RPS	MSH	30	TRANSFER PUMP NO. 3 MOISTURE SWITCH	MOISTURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
85	P	RPS	TSH	30	TRANSFER PUMP NO. 3 HIGH TEMPERATURE SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
86	P	RPS	MSH	40	TRANSFER PUMP NO. 4 MOISTURE SWITCH	MOISTURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
87	P	RPS	TSH	40	TRANSFER PUMP NO. 4 HIGH TEMPERATURE SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP001		
88	P	RPS	PIT	20	TRANSFER PUMP HEADER PRESSURE TRANSMITTER	PRESSURE TRANSMITTER	NA	4-20 mA DC	0 - XX PSI	2-WIRE	IP001	17563	
89	P	PRS	PSH	10	TRANSFER PUMP NO. 1 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IP001	17563	
90	P	PRS	PI	10	TRANSFER PUMP NO. 1 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IP001	17563	
91	P	PRS	PSH	20	TRANSFER PUMP NO. 2 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IP001	17563	
92	P	PRS	PI	20	TRANSFER PUMP NO. 2 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IP001	17563	
93	P	PRS	PSH	30	TRANSFER PUMP NO. 3 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IP001	17563	
94	P	PRS	PI	30	TRANSFER PUMP NO. 3 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IP001	17563	
95	P	PRS	PSH	40	TRANSFER PUMP NO. 4 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IP001	17563	
96	P	PRS	PI	40	TRANSFER PUMP NO. 4 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IP001	17563	
97	P	RPS	FE	20	TRANSFER PUMP HEADER COMMON FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	XX INCH	NA	NA	NA	IP001	17562	
98	P	RPS	FIT	20	TRANSFER PUMP HEADER COMMON FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IP001	17562	
99	P	RPS	MSH	50	TRANSFER PUMP NO. 5 MOISTURE SWITCH	MOISTURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP002		
100	P	RPS	TSH	50	TRANSFER PUMP NO. 5 HIGH TEMPERATURE SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP002		
101	P	RPS	PSH	50	TRANSFER PUMP NO. 5 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IP002	17563	

Sr.No	Building Code	System Code	Tag	Loop	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID	Specification	Remarks
102	P	RPS	PI	50	TRANSFER PUMP NO. 5 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IP002	17563	
103	P	RPS	MSH	60	TRANSFER PUMP NO. 6 MOISTURE SWITCH	MOISTURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP002		
104	P	RPS	TSH	60	TRANSFER PUMP NO. 6 HIGH TEMPERATURE SWITCH	TEMPERATURE SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IP002		
105	P	RPS	PSH	60	TRANSFER PUMP NO. 6 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IP002	17563	
106	P	RPS	PI	60	TRANSFER PUMP NO. 6 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IP002	17563	
107	P	RPS	LE	30	TRANSFER PUMP STATION LEVEL SENSOR	ULTRASONIC LEVEL SENSOR	NA				IP002	17563	
108	P	RPS	LIT	30	TRANSFER PUMP STATION LEVEL TRANSMITTER	ULTRASONIC LEVEL TRANSMITTER	NA	4-20 mA DC	0 - XX FT	4 WIRE	IP002	17563	
109	P	RPS	LSH	41	TRANSFER PUMP STATION HIGH LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IP002	17563	
110	P	RPS	LSL	42	TRANSFER PUMP STATION LOW LEVEL SWITCH	ELECTRODE TYPE LEVEL SWITCH	NA	DRY CONTACT		24VDC OR 120VAC	IP002	17563	
111	P	RPS	AIT	30	SRWRC TRANSFER WETWELL H2S GAS TRANSMITTER	H2S GAS CONCENTRATION TRANSMITTER		4-20 mA DC	0 - XX PPM	4 WIRE	IP002	17564	
112	P	RPS	AIT	40	SRWRC TRANSFER WETWELL CH4 GAS TRANSMITTER	CH4 GAS CONCENTRATION TRANSMITTER		4-20 mA DC	0 - XX PPM	4 WIRE	IP002	17564	
113	P	RPS	AIT	50	SRWRC TRANSFER WETWELL H2S GAS TRANSMITTER	H2S GAS CONCENTRATION TRANSMITTER		4-20 mA DC	0 - XX PPM	4 WIRE	IP002	17564	
114	P	RPS	AIT	60	SRWRC TRANSFER WETWELL CH4 GAS TRANSMITTER	CH4 GAS CONCENTRATION TRANSMITTER		4-20 mA DC	0 - XX PPM	4 WIRE	IP002	17564	
115	P	RPS	AE	30	SRWRC TRANSFER WETWELL H2S GAS SENSOR	H2S GAS CONCENTRATION SENSOR	NA		0 - XX PPM	NA	IP002	17564	
116	P	RPS	AE	40	SRWRC TRANSFER WETWELL CH4 GAS SENSOR	CH4 GAS CONCENTRATION SENSOR	NA		0 - XX PPM	NA	IP002	17564	
117	P	RPS	AE	50	SRWRC TRANSFER WETWELL H2S GAS SENSOR	H2S GAS CONCENTRATION SENSOR	NA		0 - XX PPM	NA	IP002	17564	
118	P	RPS	AE	60	SRWRC TRANSFER WETWELL CH4 GAS SENSOR	CH4 GAS CONCENTRATION SENSOR	NA		0 - XX PPM	NA	IP002	17564	
119	R	PRS	PI	10	PRIMARY SLUDGE PUMP NO. 1 LEAK SWITCH	LEAK SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IR002		FUTURE
120	R	PRS	PI	20	PRIMARY SLUDGE PUMP NO. 2 LEAK SWITCH	LEAK SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IR002		
121	R	PRS	PI	11	PRIMARY SLUDGE PUMP NO. 1 SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	FUTURE
122	R	PRS	PI	12	PRIMARY SLUDGE PUMP NO. 1 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	FUTURE
123	R	PRS	PSH	10	PRIMARY SLUDGE PUMP NO. 1 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR002	17563	FUTURE
124	R	PRS	PI	20	PRIMARY SLUDGE PUMP NO. 2. SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	
125	R	PRS	PI	21	PRIMARY SLUDGE PUMP NO. 2 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	
126	R	PRS	PSH	20	PRIMARY SLUDGE PUMP NO. 2 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR002	17563	
127	R	PRS	PI	30	PRIMARY SLUDGE PUMP NO. 3 LEAK SWITCH	LEAK SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IR002		
128	R	PRS	PI	31	PRIMARY SLUDGE PUMP NO. 3 SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	
129	R	PRS	PI	32	PRIMARY SLUDGE PUMP NO. 3 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	
130	R	PRS	PSH	30	PRIMARY SLUDGE PUMP NO. 3 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR002	17563	
131	R	PRS	PI	60	PRIMARY SLUDGE PUMP NO. 6. SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	
132	R	PRS	PI	61	PRIMARY SLUDGE PUMP NO. 6 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR002	17563	
133	R	PRS	PSH	60	PRIMARY SLUDGE PUMP NO. 6 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR002	17563	
134	R	PRS	FE	10R	PRIMARY SLUDGE PUMP NO. 1&2 COMMON DISCHARGE FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	6 INCH	NA	NA	NA	IR002	17562	
135	R	PRS	FIT	10R	PRIMARY SLUDGE PUMP NO. 1&2 COMMON DISCHARGE FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IR002	17562	
136	R	PRS	FE	20R	PRIMARY SLUDGE PUMP NO. 2&3 COMMON DISCHARGE FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	6 INCH	NA	NA	NA	IR002	17562	
137	R	PRS	FIT	20R	PRIMARY SLUDGE PUMP NO. 2&3 COMMON DISCHARGE FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IR002	17562	
138	R	PRS	FE	30R	PRIMARY SLUDGE PUMP NO. 6 COMMON DISCHARGE FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	6 INCH	NA	NA	NA	IR002	17562	
139	R	PRS	FIT	30R	PRIMARY SLUDGE PUMP NO. 6 COMMON DISCHARGE FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IR002	17562	
140	R	PRS	FE	40R	PRIMARY SLUDGE PUMP NO. 7&8 COMMON DISCHARGE FLOW SENSOR	ELECTROMAGNETIC FLOW SENSOR	6 INCH	NA	NA	NA	IR003	17562	
141	R	PRS	FIT	40R	PRIMARY SLUDGE PUMP NO. 7&8 COMMON DISCHARGE FLOW TRANSMITTER	ELECTROMAGNETIC FLOW TRANSMITTER	NA	4-20 mA DC	0 - XX GPM	4 WIRE	IR003	17562	
142	R	PRS	PI	71	PRIMARY SLUDGE PUMP NO. 7 SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	
143	R	PRS	PI	72	PRIMARY SLUDGE PUMP NO. 7 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	
144	R	PRS	PSH	70	PRIMARY SLUDGE PUMP NO. 7 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR003	17563	
145	R	PRS	PI	70	PRIMARY SLUDGE PUMP NO. 7 LEAK SWITCH	LEAK SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IR003		
146	R	PRS	PI	80	PRIMARY SLUDGE PUMP NO. 8 SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	ADDITIVE ALTERNATIVE
147	R	PRS	PI	81	PRIMARY SLUDGE PUMP NO. 8 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	ADDITIVE ALTERNATIVE
148	R	PRS	PSH	80	PRIMARY SLUDGE PUMP NO. 8 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR003	17563	ADDITIVE ALTERNATIVE
149	R	PRS	PI	80	PRIMARY SLUDGE PUMP NO. 8 LEAK SWITCH	LEAK SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IR003		ADDITIVE ALTERNATIVE
150	R	PRS	PI	11	DRAIN PUMP NO. 1 SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	
151	R	PRS	PI	12	DRAIN PUMP NO. 1 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	
152	R	PRS	PSH	10	DRAIN PUMP NO. 1 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR003	17563	
153	R	PRS	PI	10	DRAIN PUMP NO. 1 LEAK SWITCH	LEAK SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IR003		
154	R	PRS	PI	20	DRAIN PUMP NO. 2 SUCTION PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	
155	R	PRS	PI	21	DRAIN PUMP NO. 2 DISCHARGE PRESSURE INDICATOR	PRESSURE GAUGE		NA	0 - XX PSI	NA	IR003	17563	
156	R	PRS	PSH	20	DRAIN PUMP NO. 2 DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	NA	DRY CONTACT	0 - XX PSI	24VDC OR 120VAC	IR003	17563	

Sr.No	Building Code	System Code	Tag	Loop	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID	Specification	Remarks
157	R	PRS	PI	20	DRAIN PUMP NO. 2 LEAK SWITCH	LEAK SWITCH	NA	DRY CONTACT	BY SUPPLIER	24VDC OR 120VAC	IR003		

Section 17530

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 – GENERAL

1-1. SCOPE. This section covers programmable logic controllers (PLCs), including associated input/output hardware to control process equipment and serve as the interface to field devices.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all equipment furnished under this section. Additional PLC software requirements are indicated in Software Control Block Descriptions section.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings indicate the number and types of PLCs, locations of PLCs, and provide diagrams and schematics regarding connection and interaction with other equipment. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the Drawings.

1-2.03. I/O List. An input/output (I/O) field device signal listing is included as an appendix attached to this section.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System section.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System Section.

1-5. SPARE PARTS. Spare parts shall be furnished as follows:

Spare Part	Quantity
Processor modules	One(1) of each type used
PLC Application Code E-PROM	One(1) of each PLC Application
Power supply modules	One(1) of each type used
I/O modules	One (1) of each type used
Communications modules	One (1) of each type used
Isolation Devices / Modules	10% of each type used
Surge Protection Devices	10% of each type used

Where a percentage is listed, a minimum of one (1) unit is required. All computed percentages over 0.5% shall be rounded up to the next whole unit quantity.

PART 2 - PRODUCTS

2-1. GENERAL. All equipment furnished under this section shall be expressly selected by System Supplier for its superior quality for the intended purpose and shall comply with the following requirements.

2-1.01. Interchangeability. All programmable logic controller systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules such as coprocessors and ASCII modules shall be interchangeable among all I/O panels and systems. PLC modules and hardware by other manufacturers will be acceptable only if the PLC manufacturer does not offer suitable modules and hardware for the same functions.

2-1.02. Initial, Spare, and Future Memory (RAM). System Supplier shall provide adequate memory for the amount of I/O, control algorithms, and communications in the initial system.

Each programmable logic controller shall include provisions for future expansion and shall have 100 percent spare memory capacity and 100 percent spare data capacity installed. The spare memory capacity shall be documented by submitting to Engineer, during factory testing, a statement indicating the amounts of memory of all types being utilized and the total amount available in each system. The statement shall include an

estimate of the total program and data memory necessary, including spare memory, based on the I/O hardware for the system, and previous programming experience.

2-1.03. Spare I/O. Each PLC input/output enclosure shall be provided with at least 20 percent spare inputs and outputs of each type. Spare I/O shall be installed, wired, and interfaced properly to the terminal strip. The spare I/O shall be in addition to any I/O installed and reserved for future process signals as may be indicated on the I/O list. In addition, each PLC input/output enclosure shall be capable of accommodating 20 percent of additional input/output capacity of each type as originally assembled, without the need for additional expansion racks, communication adapters, cables, or PLC power supplies.

2-1.04. Expandability. Each PLC processor and associated I/O shall have a future expandability of at least twenty-five (25) percent of the provided system.

2-1.05. Acceptable Manufacturers. The PLCs shall be Rockwell Automation ControlLogix without exception to maintain compatibility with OWNER's existing PLC equipment standards.

2-1.06. Signal Power Supplies. Regulated dc power supplies shall be provided in each PLC enclosure for analog inputs, analog outputs, digital outputs, and digital inputs. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or protected against short-circuiting. Output voltage regulation shall be as required by the instrumentation equipment supplied under another section.

The loop power supply shall be separate from the power supply circuit for the processor and racks.

The power source for all digital inputs from field devices shall be separately fused for each digital input module. Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

2-1.07. Appurtenances. The PLC processor and I/O hardware shall be provided as complete systems, as shown on the block diagram drawings. The PLCs shall include all necessary hardware and software for a complete working system. All special rack or panel mounted power supplies, special interconnecting and programming cables, special grounding hardware, or isolation devices shall be furnished for proper operation of the equipment. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, intrinsically safe relays and current repeaters, surge suppression devices, and isolation devices shall be furnished and installed for proper operation of the equipment.

2-1.08. PLC Arrangement. The PLCs shall be distributed and arranged as indicated on

the Drawings.

2-1.09. Service Conditions. PLCs will be installed in air conditioned rooms.

2-2. LARGE PLC PROCESSOR. The programmable logic controller processor shall be an industrial-type rack-mounted unit that utilizes battery-backed CMOS type or nonvolatile type memory. Battery backed memory shall include integral batteries with sufficient capacity for at least 6 months' memory retention without power to the processing unit. Standby and shelf life of the batteries shall be at least 5 years.

The system shall include an Erasable Programmable Read Only Memory (EPROM) card for storage of the user program. The processor shall automatically download the user program from the EPROM upon startup after a power loss. The EPROM shall be programmable by the PLC or PLC software, without the use of external PROM programmable equipment.

2-2.01. Diagnostics. The processor shall utilize self-monitoring diagnostic techniques and shall contain easily visible LED diagnostic indicators for "run" and "halt" conditions as well as memory and input/output error conditions. Diagnostic codes shall also be available through the programming device to facilitate troubleshooting.

2-2.02. Programming Port. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional, and after all communications, human machine interface (HMI), and network connections have been made. Removal or disruption of network communications, remote I/O communications, and HMIs to allow for on-line programming and monitoring will not be acceptable. A key switch shall be provided on the processor for selection of the operating mode and as a security measure.

2-2.03. Communications. The processor shall be programmed to operate autonomously, regardless of communications status with other units. Each programmable controller shall be furnished complete with communication modules for local and remote input/output hardware communications, communications with other programmable controllers, and communication with host computers as shown on the block diagram.

2-2.04. Environment. The processor shall be suitable for operation in the environments specified in another section.

2-2.05. Programming. The processor shall be programmable using the IEC 1131-3. international programming standards and ladder logic programming. IEC 1131-3 programming shall include the following:

Functional Block Diagram

Sequential Function Chart.

Instruction List.

Structured Text.

Ladder Diagram.

Ladder logic programming shall include a minimum of the following capabilities:

Contacts, coils, branching.

Data comparisons.

On-delay and off-delay timers.

Counters with comparators.

Floating point Math and Logical instructions.

PID loop control.

Jumps and Subroutine functions.

Master control relay.

Transitional or one-shot outputs.

Standard and user-defined data tables for digital and analog value storage.

Remote I/O capability.

Fault-mode subroutine.

2-2.06. Programming Capabilities. The processor shall include the following capabilities for programming, debugging of programs, and troubleshooting.

Off-line programming.

On-line programming.

On-line status of coils and registers.

Input/output forcing.

2-2.07. Hardware Configuration. Processors shall be configured for standard rack mounting. Each programmable logic controller processor shall include integral communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces.

2-2.08. Input/Output Hardware. Input/output hardware shall be arranged as indicated on the Drawings. Programmable logic controller systems shall support the following types of input/output modules.

120 volt ac digital input and output.

24 volt dc digital input and output.

4-20 mA dc analog input and output.

All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet the following requirements.

2-2.08.01. Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2-2.08.02. I/O Circuit Power Supply. Outputs shall be fully isolated through interposing relays in the PLC cabinet. Where 24 vdc is used for I/O, redundant DC power shall be provided with alarm contact status output for a DC power supply failure.

2-2.08.03. Digital Input Modules. Digital input modules shall sense voltages between 100 and 130 volts ac, 20 and 28 volts dc, or 90 – 146 volts dc and shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Digital input modules shall provide complete electrical isolation between individual inputs. Digital input modules shall have multiple inputs.

2-2.08-04. Digital Output Modules. Digital output modules shall control voltages from 100 and 130volts ac, 20 and 28 volts dc, or 90 and 146 volts dc and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2.0 mA. Digital output modules shall provide complete electrical isolation between individual output circuits. Digital output modules shall have multiple outputs.

2-2.08.05. Relay Digital Output Modules. Not used.

2-2.08.06. Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Analog to digital conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog input modules shall have multiple inputs. Each input shall be fully isolated from the other inputs.

2-2.08.07. Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by

regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600 ohm load. Digital to analog conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog output modules shall have multiple outputs.

2-2.08.08. Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2-2.08.09. Interposing Relays. Interposing relays shall be incorporated on all I/O circuits as shown on the PLC input/output listing, where required by the application of isolate foreign power sources, where the continuous output rating of the PLC relay digital or output module is not sufficient to power the connected device or equipment, or where otherwise required by the System Supplier's equipment. Interposing relays shall be provided for any digital output module output signal that leaves the PLC enclosure. Interposing relays shall be mounted in the PLC enclosure containing the output module that activates the relays.

2-3. MINI PLC PROCESSOR. Not used

2-4. COMMUNICATIONS. Each programmable controller system shall be furnished complete with communication hardware modules for local input/output hardware, remote input/output hardware, other programmable controllers, or for host computers.

Communication hardware shall be compatible with the cable, data highway, fiber optic, or radio communication media. Ethernet components and cable are specified in other specification sections.

2-4.01. Addressability. Each programmable logic controller shall be individually addressable so that only the selected controller responds when queried. IP addressing shall be used. Designation of a controller's network address may be either a software or hardware function.

2-4.02. Communications Hardware. System Supplier shall provide all necessary communications hardware. Hardware shall be included for, but not be limited to, remote I/O, data highway, host computer, fiber optics, Ethernet and radio.

2-4.02.01. PLC to PLC Communications Hardware. As shown on the network diagram and required per application, any PLC to PLC communication shall be via an Ethernet data highway communications network via fiber-optic cabling. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2-4.02.02. PLC to Remote Communications Hardware Each PLC (as shown on plans) requiring remote I/O shall communicate to the remote I/O over an Ethernet data

highway communications network via fiber-optic cabling. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2-4.02.03. PLC to Host Communications Hardware. Each PLC shall communicate to the host computer over an Ethernet data highway communications network via fiber-optic cabling. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system. The computer system hardware is covered in another section.

2-4.03. Communications Media. System Supplier shall provide all necessary cabling for the PLC communications network and any PLC remote I/O communications network. Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules. PLC communications media shall be as specified under the Network Systems section.

2-5. MEDIA CONVERTERS. Not Used

2-6. TELEPHONE NETWORKS. Not Used.

2-7. SERIAL NETWORKS. Not Used.

2-8. PROGRAMMING DEVICE HARDWARE. The programming device shall be a portable notebook computer. System Supplier shall provide two interconnecting cables, each 5 meters long, to connect the computer to the programmable logic controller. The cables shall be shielded data cable and shall be terminated on both ends with the appropriate connectors. Connectors shall be labeled to identify the connected equipment.

2-8.01. Special Devices. System Supplier shall provide two sets of any special devices (such as null modems, adapter cards, interface converters, etc.) required to establish an operational programming line between the programmable logic controllers and programming device.

2-9. PROGRAMMING SOFTWARE. System Supplier shall furnish one licensed copy of PLC programming software to Owner. The software shall be suitable for running on a laptop computer running Windows 7 (or later) operating system software. A full legal set of programming software documentation shall accompany each copy of the software. Each copy of the programming software shall include all necessary device drivers and add-on software packages.

2-9.01. Standard Product. The programming software shall be personal computer based and a standard product of the PLC manufacturer. The software shall be Rockwell Automation RSLogix 5000.

2-9.02. PLC Simulation. The programming software shall include a PLC simulation feature that allows the program logic of a single PLC to be tested and debugged entirely in the programming device without the PLC.

2-9.03. Programming Software Features. The programming software shall allow off-line development of all PLC-related programming, including user annotation of the program, and creation and printing of application programs and I/O cross-reference lists. Special programming tasks originally provided by System Supplier shall also be included.

On-line features shall include IEC-1311-3 standards program modification, ladder-logic modification, program language modification, monitoring of real-time ladder-logic execution, monitoring of program execution, monitoring and manipulation of timer and counter preset and present values, monitoring and forcing of physical I/O, and monitoring and manipulation of analog (register) and bit (binary) data table values. PLC and I/O hardware diagnostic and status information shall be accessible using the software in on-line mode.

2-10. SYSTEM ENCLOSURES. Programmable logic controllers and input/output hardware shall be housed in shop-assembled panels as indicated on the Drawings and as described in the Panels, Consoles, and Appurtenances section.

2-11. OPERATOR INTERFACE TERMINALS. Operator interface terminals (OIT) shall be microprocessor-based flat panel type based on an industrialized personal computer platform. The unit shall have data entry capabilities and shall include a password security function. The unit shall be connected to the PLC via Ethernet and shall display status, alarm, and diagnostic information.

The OIT shall provide a nominal TFT LED panel diagonal display area dimension of 17", with a minimum resolution of 1280x1024, 262K colors, luminance of 350 cd/$m^{2,}$ contrast ratio of 1000, operating temperature of 0 to 50 deg. C.

The OIT shall be furnished with latest and fastest available Intel processor Core (i7 minimum) mobile processor (PGA), furnished with a minimum of 8 GB of computer memory, supporting up to 16GB of memory, and furnished with a 1.0 TB (1000 GB) minimum capacity Solid-State Hard Disk Drive for operating system, application software and local data storage.

The operator interface unit shall be provided with two (2) Ethernet ports for communications, and multiple USB ports for portable device interfacing and backup. The OIT shall be rated NEMA 4X, suitable for panel face mounting.

Operating system shall be Windows Version 7 64-bit Professional Edition.

Terminals shall be powered from 120 V ac, 60 Hz, single phase or 18 to 32 volts DC. Terminals shall be suitable for ambient temperatures of +32 to +130°F and a relative humidity of 5 to 95 percent.

The OIT application software shall be the current commercially available version of Wonderware InTouch with tag count license and historical data storage capacity suitable for application with a minimum of 50% expansion capacity.

Two (2) complete Wonderware InTouch development systems (one for ICWRC and one for SRWRC) shall be provided to Owner for support of all System Supplier and Packaged Equipment Supplier furnished Industrial Panel Mounted OIT

The operator interface unit shall be Advantech PPC-8170 17" Panel PC with Mini-iTX AIMB Motherboard support or Owner and Engineer approved equal.

Each OIT shall provide graphic screens that shall be used by the operators to access all functions and set-points necessary for comprehensive control. The Manufacturer shall be responsible for developing and configuring the custom graphic displays in coordination with Foxboro in order to ensure a consistent graphical user interface on both the OIT and Foxboro EVO DCS graphical workstations.

Each piece of major process equipment that is monitored and controlled by the control system shall be displayed on the graphic screens. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. The manufacturer shall use the configuration standards and conventions to be established by direct coordination with the Owner that shall describe and define such items as proposed graphic display process line colors/representations; color standards for "on", "off", "opened", "closed", and "alarm" conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Proposed displays shall be submitted to the Engineer and Owner for approval.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. PLCs installation requirements are specified in Instrumentation and Control System section except as described herein.

Field check, testing, and training shall be as specified in the Instrumentation and Control System section.

3-2. CONFIGURATION.

3-2.01. PLC Programming and Configuration. Configuration services are specified in the Instrumentation and Control System section.

3-2.02. Communications Configuration. The communications shall be fully configured and installed by System Supplier. Communications shall be configured as shown on the Drawings.

End of Section

Input/Output List - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only.
IO Type: This is the type of I/O signal, as follows:
AI = Analog Input
AO = Analog Output
DI = Discrete Input
DO = Discrete Output
PI = Pulse Input (totalizer or accumulator type input)
Description. This is the description or the function (i.e. Filter No. 1 Loss-of-Head).
Field Device. This is the tag number of equipment identifier associated with the I/O point.
Controller ID. This is a sequential number for a given type within a specific controller (PLC or DCU).
Analog Data (Signal Type). This will typically be 4-20mA, but could also be 1-5Vdc, serial, HART, FLD-BUS, or similar to indicate the signal type of the associated input or output.
Analog Data (Calibrated Range). This will be the scaled value of the input in engineering units.
Analog Data (Power). This will typically be '2-wire' for devices which are loop powered from the PLC enclosure, or '4-wire' for devices which are powered form external power supplies, unless noted otherwise.
Discrete Data (Signal Type). This will be 120VAC, 24VDC, or similar to indicate the signal type of the associated input or output.
Discrete Data (Closed State). This will indicate the state of the input or output when it is considered to be closed or energized (normal, alarm, running, failed, etc.).
Discrete Data (Power Source). This will indicate the location of the power source for the wetting voltage on the contacts, as follows:
Field = External field power source. (May require interposing relays or isolated I/O module type.)
Local = Power originates from within the PLC or I/O enclosure.
Discrete Data (Interp Relay). This will be either 'Yes' or 'No' to indicate whether the input or output requires an interposing relay. Relays are typically required to isolate external voltage sources. See specifications for additional details.
P&ID. This column indicates associated Process & Instrumentation Diagram.
Remarks. This column may include a cross reference to another specification section where applicable, or to a note which provides additional information. Notes are appended to the end of the I/O listing.

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
1	DI	JUNCTION BOX GATE NO. 1 OPENED	B-PRC-GSD-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IB001	EXISTING
2	DI	JUNCTION BOX GATE NO. 1 CLOSED	B-PRC-GSD-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IB001	EXISTING
3	DI	JUNCTION BOX GATE NO. 1 IN REMOTE	B-PRC-GSD-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	EXISTING
4	DI	JUNCTION BOX GATE NO. 1 FAULT	B-PRC-GSD-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IB001	EXISTING
5	DO	JUNCTION BOX GATE NO. 1 OPEN CMD	B-PRC-GSD-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IB001	EXISTING
6	DO	JUNCTION BOX GATE NO. 1 CLOSE CMD	B-PRC-GSD-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IB001	EXISTING
7	DI	JUNCTION BOX GATE NO. 2 CLOSED	B-PRC-GSD-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IB001	
8	DI	JUNCTION BOX GATE NO. 2 OPENED	B-PRC-GSD-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IB001	
9	DI	JUNCTION BOX GATE NO. 2 IN REMOTE	B-PRC-GSD-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	
10	DI	JUNCTION BOX GATE NO. 2 FAULT	B-PRC-GSD-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IB001	
11	DO	JUNCTION BOX GATE NO. 2 CLOSE CMD	B-PRC-GSD-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IB001	
12	DO	JUNCTION BOX GATE NO. 2 OPEN CMD	B-PRC-GSD-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IB001	
13	DI	JUNCTION BOX GATE NO. 3 OPENED	B-PRC-GSD-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IB001	
14	DI	JUNCTION BOX GATE NO. 3 IN REMOTE	B-PRC-GSD-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	
15	DI	JUNCTION BOX GATE NO. 3 CLOSED	B-PRC-GSD-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IB001	
16	DI	JUNCTION BOX GATE NO. 3 FAULT	B-PRC-GSD-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IB001	
17	DO	JUNCTION BOX GATE NO. 3 OPEN CMD	B-PRC-GSD-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IB001	
18	DO	JUNCTION BOX GATE NO. 3 CLOSE CMD	B-PRC-GSD-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IB001	
19	DI	JUNCTION BOX GATE NO. 4 CLOSED	B-PRC-GSD-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IB001	ADDITIVE ALTERNATIVE
20	DI	JUNCTION BOX GATE NO. 4 IN REMOTE	B-PRC-GSD-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	ADDITIVE ALTERNATIVE
21	DI	JUNCTION BOX GATE NO. 4 OPENED	B-PRC-GSD-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IB001	ADDITIVE ALTERNATIVE
22	DI	JUNCTION BOX GATE NO. 4 FAULT	B-PRC-GSD-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IB001	ADDITIVE ALTERNATIVE
23	DO	JUNCTION BOX GATE NO. 4 CLOSE CMD	B-PRC-GSD-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IB001	ADDITIVE ALTERNATIVE
24	DO	JUNCTION BOX GATE NO. 4 OPEN CMD	B-PRC-GSD-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IB001	ADDITIVE ALTERNATIVE
25	DI	JUNCTION BOX MIXER NO. 1 IN REMOTE	B-PRC-LCP-MXP-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	
26	DI	JUNCTION BOX MIXER NO. 1 FAILED	B-PRC-LCP-MXP-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB001	
27	DI	JUNCTION BOX MIXER NO. 1 RUNNING	B-PRC-LCP-MXP-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB001	
28	DI	JUNCTION BOX MIXER NO. 2 IN REMOTE	B-PRC-LCP-MXP-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	EXISTING
29	DI	JUNCTION BOX MIXER NO. 2 FAILED	B-PRC-LCP-MXP-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB001	EXISTING
30	DI	JUNCTION BOX MIXER NO. 2 RUNNING	B-PRC-LCP-MXP-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB001	EXISTING
31	DI	JUNCTION BOX MIXER NO. 3 IN REMOTE	B-PRC-LCP-MXP-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	
32	DI	JUNCTION BOX MIXER NO. 3 FAILED	B-PRC-LCP-MXP-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB001	
33	DI	JUNCTION BOX MIXER NO. 3 RUNNING	B-PRC-LCP-MXP-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB001	
34	DI	JUNCTION BOX MIXER NO. 4 IN REMOTE	B-PRC-LCP-MXP-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB001	EXISTING
35	DI	JUNCTION BOX MIXER NO. 4 FAILED	B-PRC-LCP-MXP-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB001	EXISTING

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
36	DI	JUNCTION BOX MIXER NO. 4 RUNNING	B-PRC-LCP-MXP-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB001	EXISTING
37	DI	CLARIFIER INFLUENT JUNCTION BOX HIGH LEVEL	B-PRC-LSH-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IB001	
38	DO	JUNCTION BOX MIXER NO. 1 RUN CMD	B-PRC-MXP-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	START CMD	PLC	Yes	IB001	
39	DO	JUNCTION BOX MIXER NO. 2 RUN CMD	B-PRC-MXP-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	START CMD	PLC	Yes	IB001	EXISTING
40	DO	JUNCTION BOX MIXER NO. 3 RUN CMD	B-PRC-MXP-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	START CMD	PLC	Yes	IB001	
41	DO	JUNCTION BOX MIXER NO. 4 RUN CMD	B-PRC-MXP-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	START CMD	PLC	Yes	IB001	EXISTING
42	AI	PRIMARY CLARIFIER NO. 1 TORQUE INDICATION	B-PRC-LCP-PCLR-10	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IB002	EXISTING
43	DI	PRIMARY CLARIFIER NO. 1 FAILED	B-PRC-LCP-PCLR-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB002	EXISTING
44	DI	PRIMARY CLARIFIER RACK NO. 1 TORQUE SHUTDOWN	B-PRC-LCP-PCLR-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	TORQUE SHUTDOWN	PLC	No	IB002	EXISTING
45	DI	PRIMARY CLARIFIER HYDRAULIC UNIT NO. 1 LOW OIL PRESSURE	B-PRC-LCP-PCLR-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LOW OIL PRESSURE	PLC	No	IB002	EXISTING
46	DI	PRIMARY CLARIFIER NO. 1 HIGH TORQUE	B-PRC-LCP-PCLR-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IB002	EXISTING
47	DI	PRIMARY CLARIFIER NO. 1 RUNNING	B-PRC-LCP-PCLR-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB002	EXISTING
48	AI	PRIMARY CLARIFIER NO. 2 TORQUE INDICATION	B-PRC-LCP-PCLR-20	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IB002	
49	DI	PRIMARY CLARIFIER NO. 2 FAILED	B-PRC-LCP-PCLR-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB002	
50	DI	PRIMARY CLARIFIER RACK NO. 2 TORQUE SHUTDOWN	B-PRC-LCP-PCLR-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	TORQUE SHUTDOWN	PLC	No	IB002	
51	DI	PRIMARY CLARIFIER HYDRAULIC UNIT NO. 2 LOW OIL PRESSURE	B-PRC-LCP-PCLR-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LOW OIL PRESSURE	PLC	No	IB002	
52	DI	PRIMARY CLARIFIER NO. 2 HIGH TORQUE	B-PRC-LCP-PCLR-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IB002	
53	DI	PRIMARY CLARIFIER NO. 2 RUNNING	B-PRC-LCP-PCLR-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB002	
54	AI	PRIMARY CLARIFIER NO. 1 SLUDGE BLANKET LEVEL	B-PRC-LIT-10	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IB002	EXISTING
55	AI	PRIMARY CLARIFIER NO. 2 SLUDGE BLANKET LEVEL	B-PRC-LIT-20	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IB002	
56	AI	PRIMARY CLARIFIER NO. 3 TORQUE INDICATION	B-PRC-LCP-PCLR-30	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IB003	
57	DI	PRIMARY CLARIFIER NO. 3 FAILED	B-PRC-LCP-PCLR-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB003	
58	DI	PRIMARY CLARIFIER RACK NO. 3 TORQUE SHUTDOWN	B-PRC-LCP-PCLR-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	TORQUE SHUTDOWN	PLC	No	IB003	
59	DI	PRIMARY CLARIFIER HYDRAULIC UNIT NO. 3 LOW OIL PRESSURE	B-PRC-LCP-PCLR-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LOW OIL PRESSURE	PLC	No	IB003	
60	DI	PRIMARY CLARIFIER NO. 3 HIGH TORQUE	B-PRC-LCP-PCLR-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IB003	
61	DI	PRIMARY CLARIFIER NO. 3 RUNNING	B-PRC-LCP-PCLR-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB003	
62	AI	PRIMARY CLARIFIER NO. 4 TORQUE INDICATION	B-PRC-LCP-PCLR-40	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IB003	ADDITIVE ALTERNATIVE
63	DI	PRIMARY CLARIFIER NO. 4 FAILED	B-PRC-LCP-PCLR-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB003	ADDITIVE ALTERNATIVE
64	DI	PRIMARY CLARIFIER RACK NO. 4 TORQUE SHUTDOWN	B-PRC-LCP-PCLR-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	TORQUE SHUTDOWN	PLC	No	IB003	ADDITIVE ALTERNATIVE
65	DI	PRIMARY CLARIFIER HYDRAULIC UNIT NO. 4 LOW OIL PRESSURE	B-PRC-LCP-PCLR-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LOW OIL PRESSURE	PLC	No	IB003	ADDITIVE ALTERNATIVE
66	DI	PRIMARY CLARIFIER NO. 4 HIGH TORQUE	B-PRC-LCP-PCLR-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IB003	ADDITIVE ALTERNATIVE
67	DI	PRIMARY CLARIFIER NO. 4 RUNNING	B-PRC-LCP-PCLR-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB003	ADDITIVE ALTERNATIVE
68	AI	PRIMARY CLARIFIER NO. 3 SLUDGE BLANKET LEVEL	B-PRC-LIT-30	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IB003	
69	AI	PRIMARY CLARIFIER NO. 4 SLUDGE BLANKET LEVEL	B-PRC-LIT-40	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IB003	ADDITIVE ALTERNATIVE
70	DI	SCUM WELL NO. 1 LEVEL HIGH	B-PSC-LSH-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IB004	
71	DI	SCUM WELL NO. 2 LEVEL HIGH	B-PSC-LSH-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IB004	
72	DI	SCUM WELL NO. 1 LEVEL HIGH HIGH	B-PSC-LSHH-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH HIGH	PLC	No	IB004	
73	DI	SCUM WELL NO. 2 LEVEL HIGH HIGH	B-PSC-LSHH-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH HIGH	PLC	No	IB004	
74	DI	SCUM WELL NO. 1 LEVEL LOW LOW	B-PSC-LSL-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL LOW LOW	PLC	No	IB004	
75	DI	SCUM WELL NO. 2 LEVEL LOW LOW	B-PSC-LSL-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL LOW LOW	PLC	No	IB004	
76	DO	SCUM PUMP NO. 1 RUN CMD	B-PSC-PCL-10	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IB004	
77	DO	SCUM PUMP NO. 2 RUN CMD	B-PSC-PCL-20	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IB004	
78	DO	SCUM PUMP NO. 3 RUN CMD	B-PSC-PCL-30	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IB004	
79	DO	SCUM PUMP NO. 4 RUN CMD	B-PSC-PCL-40	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IB004	
80	DI	SCUM PUMP NO. 1 FAILED	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB004	
81	DI	SCUM PUMP NO. 1 HIGH MOTOR TEMP.	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IB004	
82	DI	SCUM PUMP NO. 1 IN REMOTE	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB004	
83	DI	SCUM PUMP NO. 1 RUNNING	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB004	
84	DI	SCUM PUMP NO. 2 FAILED	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB004	
85	DI	SCUM PUMP NO. 2 HIGH MOTOR TEMP.	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IB004	
86	DI	SCUM PUMP NO. 2 IN REMOTE	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB004	
87	DI	SCUM PUMP NO. 2 RUNNING	B-PSC-PRC-1-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB004	
88	DI	SCUM PUMP NO. 3 FAILED	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB004	
89	DI	SCUM PUMP NO. 3 HIGH MOTOR TEMP.	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IB004	
90	DI	SCUM PUMP NO. 3 IN REMOTE	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB004	
91	DI	SCUM PUMP NO. 3 RUNNING	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB004	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
92	DI	SCUM PUMP NO. 4 FAILED	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IB004	
93	DI	SCUM PUMP NO. 4 HIGH MOTOR TEMP.	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IB004	
94	DI	SCUM PUMP NO. 4 IN REMOTE	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IB004	
95	DI	SCUM PUMP NO. 4 RUNNING	B-PSC-PRC-2-LCP	SRWRC PLC-HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IB004	
96	AI	INFLUENT JUNCTION BOX FLOW 3 FLOW RATE	B-PRC-FIT-30	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IB005	
97	AI	INFLUENT JUNCTION BOX FLOW 1 FLOW RATE	B-PRC-FIT-40	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IB005	
98	AI	INFLUENT JUNCTION BOX FLOW 2 FLOW RATE	B-PRC-FIT-50	SRWRC PLC-HEADHOUSE	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IB005	
99	AI	FERRIC CHLORIDE STORAGE TANK NO. 1 LEVEL	C-FECL-LIT-100	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IC007	
100	AI	FERRIC CHLORIDE STORAGE TANK NO. 2 LEVEL	C-FECL-LIT-200	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IC007	
101	AI	FERRIC CHLORIDE PUMP NO. 1 FLOW RATE	C-FECL-FIT-100	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IC009	
102	AI	FERRIC CHLORIDE PUMP NO. 2 FLOW RATE	C-FECL-FIT-200	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IC009	
103	AI	FERRIC CHLORIDE PUMP NO. 3 FLOW RATE	C-FECL-FIT-300	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IC009	
104	DI	FERRIC CHLORIDE PUMP NO. 1 FAIL	C-FECL-PPS-100	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IC009	
105	DI	FERRIC CHLORIDE PUMP NO. 1 IN REMOTE	C-FECL-PPS-100	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IC009	
106	DO	FERRIC CHLORIDE PUMP NO. 1 RUN COMMAND	C-FECL-PPS-100	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	FIELD	Yes	IC009	
107	DI	FERRIC CHLORIDE PUMP NO. 1 RUNNING	C-FECL-PPS-100	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IC009	
108	AI	FERRIC CHLORIDE PUMP NO. 1 STROKE SPEED INDICATION	C-FECL-PPS-100	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IC009	
109	AO	FERRIC CHLORIDE PUMP NO. 1 STROKE SPEED SETPOINT	C-FECL-PPS-100	SRWRC PLC - CHEMICAL	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	N/A	IC009	
110	DI	FERRIC CHLORIDE PUMP NO. 2 FAIL	C-FECL-PPS-200	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IC009	
111	DI	FERRIC CHLORIDE PUMP NO. 2 IN REMOTE	C-FECL-PPS-200	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IC009	
112	DO	FERRIC CHLORIDE PUMP NO. 2 RUN COMMAND	C-FECL-PPS-200	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	FEILD	Yes	IC009	
113	DI	FERRIC CHLORIDE PUMP NO. 2 RUNNING	C-FECL-PPS-200	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IC009	
114	AI	FERRIC CHLORIDE PUMP NO. 2 STROKE SPEED INDICATION	C-FECL-PPS-200	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IC009	
115	AO	FERRIC CHLORIDE PUMP NO. 2 STROKE SPEED SETPOINT	C-FECL-PPS-200	SRWRC PLC - CHEMICAL	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	N/A	IC009	
116	DI	FERRIC CHLORIDE PUMP NO. 3 FAIL	C-FECL-PPS-300	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IC009	
117	DI	FERRIC CHLORIDE PUMP NO. 3 IN REMOTE	C-FECL-PPS-300	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IC009	
118	DO	FERRIC CHLORIDE PUMP NO. 3 RUN COMMAND	C-FECL-PPS-300	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	FEILD	Yes	IC009	
119	DI	FERRIC CHLORIDE PUMP NO. 3 RUNNING	C-FECL-PPS-300	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IC009	
120	AI	FERRIC CHLORIDE PUMP NO. 3 STROKE SPEED INDICATION	C-FECL-PPS-300	SRWRC PLC - CHEMICAL	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IC009	
121	AO	FERRIC CHLORIDE PUMP NO. 3 STROKE SPEED SETPOINT	C-FECL-PPS-300	SRWRC PLC - CHEMICAL	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	N/A	IC009	
122	DI	FERRIC CHLORIDE PUMP NO. 1 HIGH DISCHARGE PRESSURE	C-FECL-PSH-100	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IC009	
123	DI	FERRIC CHLORIDE PUMP NO. 2 HIGH DISCHARGE PRESSURE	C-FECL-PSH-200	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IC009	
124	DI	FERRIC CHLORIDE PUMP NO. 3 HIGH DISCHARGE PRESSURE	C-FECL-PSH-300	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IC009	
125	DI	CHEMICAL UPS FAULT	C-FECL-UPS-XXX	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IC009	
126	DI	CHEMICAL AC POWER OK	C-FECL-UPS-XXX	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	OK	PLC	No	IC009	
127	DI	CHEMICAL BUILDING EYEWASH FLOW ACTIVATED	C-FECL-ES/EEW-1	SRWRC PLC - CHEMICAL	N/A	N/A	N/A	24VDC OR 120VAC	OK	PLC	No	IC009	
128	AI	EQUILIZATION TANK NO. 1 LEVEL	F-EQB-LIT-10-1	ICWRC PLC - XFR PS REMOTE I/O	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IF003	
129	AI	EQUILIZATION TANK NO. 1 LEVEL(BACKUP)	F-EQB-LIT-10-2	ICWRC PLC - XFR PS REMOTE I/O	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IF003	
130	AI	EQUILIZATION TANK NO. 2 LEVEL	F-EQB-LIT-10-3	ICWRC PLC - XFR PS REMOTE I/O	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IF003	ADDITIVE ALTERNATIVE
131	AI	EQUILIZATION TANK NO. 2 LEVEL(BACKUP)	F-EQB-LIT-10-4	ICWRC PLC - XFR PS REMOTE I/O	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IF003	ADDITIVE ALTERNATIVE
132	AI	EQ. TANK TRANSFER PUMP COMMON HEADER PRESSURE	F-EQB-PIT-10	ICWRC PLC - XFR PS REMOTE I/O	4-20 mA DC	0 - XX PSI	2-WIRE	N/A	N/A	N/A	N/A	IF003	
133	DI	EQ. TANK NO. 1 OUTLET VALVE CLOSED	F-EQB-VPL-100	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IF003	EXISTING
134	DI	EQ. TANK NO. 1 OUTLET VALVE FAILED	F-EQB-VPL-100	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IF003	EXISTING
135	DI	EQ. TANK NO. 1 OUTLET VALVE OPENED	F-EQB-VPL-100	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IF003	EXISTING
136	DI	EQ. TANK NO. 1 OUTLET VALVE IN REMOTE	F-EQB-VPL-100	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	No	IF003	EXISTING
137	DO	EQ. TANK NO. 1 OUTLET VALVE CLOSE CMD	F-EQB-VPL-100	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IF003	EXISTING
138	DO	EQ. TANK NO. 1 OUTLET VALVE OPEN CMD	F-EQB-VPL-100	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IF003	EXISTING
139	DI	EQ. TANK NO. 2 INLET VALVE CLOSED	F-EQB-VPL-101	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IF003	ADDITIVE ALTERNATIVE
140	DI	EQ. TANK NO. 2 INLET VALVE FAILED	F-EQB-VPL-101	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IF003	ADDITIVE ALTERNATIVE
141	DI	EQ. TANK NO. 2 INLET VALVE OPENED	F-EQB-VPL-101	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IF003	ADDITIVE ALTERNATIVE
142	DI	EQ. TANK NO. 2 INLET VALVE IN REMOTE	F-EQB-VPL-101	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	No	IF003	ADDITIVE ALTERNATIVE
143	DO	EQ. TANK NO. 2 INLET VALVE CLOSE CMD	F-EQB-VPL-101	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IF003	ADDITIVE ALTERNATIVE
144	DO	EQ. TANK NO. 2 INLET VALVE OPEN CMD	F-EQB-VPL-101	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IF003	ADDITIVE ALTERNATIVE

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
145	DI	EQ. TANK NO. 2 OUTLET VALVE CLOSED	F-EQB-VPL-102	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IF003	ADDITIVE ALTERNATIVE
146	DI	EQ. TANK NO. 2 OUTLET VALVE FAILED	F-EQB-VPL-102	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IF003	ADDITIVE ALTERNATIVE
147	DI	EQ. TANK NO. 2 OUTLET VALVE OPENED	F-EQB-VPL-102	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IF003	ADDITIVE ALTERNATIVE
148	DI	EQ. TANK NO. 2 OUTLET VALVE IN REMOTE	F-EQB-VPL-102	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	No	IF003	ADDITIVE ALTERNATIVE
149	DO	EQ. TANK NO. 2 OUTLET VALVE CLOSE CMD	F-EQB-VPL-102	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IF003	ADDITIVE ALTERNATIVE
150	DO	EQ. TANK NO. 2 OUTLET VALVE OPEN CMD	F-EQB-VPL-102	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IF003	ADDITIVE ALTERNATIVE
151	DI	EQ. TANK NO. 1 INLET VALVE CLOSED	F-EQB-VPL-70	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IF003	EXISTING
152	DI	EQ. TANK NO. 1 INLET VALVE FAILED	F-EQB-VPL-70	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IF003	EXISTING
153	DI	EQ. TANK NO. 1 INLET VALVE OPENED	F-EQB-VPL-70	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IF003	EXISTING
154	DI	EQ. TANK NO. 1 INLET VALVE IN REMOTE	F-EQB-VPL-70	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	No	IF003	EXISTING
155	DO	EQ. TANK NO. 1 INLET VALVE CLOSE CMD	F-EQB-VPL-70	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IF003	EXISTING
156	DO	EQ. TANK NO. 1 INLET VALVE OPEN CMD	F-EQB-VPL-70	ICWRC PLC - XFR PS REMOTE I/O	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IF003	EXISTING
157	DO	SCREEN TRAIN 1 INLET CHANNEL GATE CLOSE CMD	H-SCR-GSC-01	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH001	
158	DI	SCREEN TRAIN 1 INLET CHANNEL GATE CLOSED	H-SCR-GSC-01	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH001	
159	DI	SCREEN TRAIN 1 INLET CHANNEL GATE FAILED	H-SCR-GSC-01	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH001	
160	DI	SCREEN TRAIN 1 INLET CHANNEL GATE IN REMOTE	H-SCR-GSC-01	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH001	
161	DO	SCREEN TRAIN 1 INLET CHANNEL GATE OPEN CMD	H-SCR-GSC-01	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH001	
162	DI	SCREEN TRAIN 1 INLET CHANNEL GATE OPENED	H-SCR-GSC-01	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH001	
163	DO	SCREEN TRAIN 2 INLET CHANNEL GATE CLOSE CMD	H-SCR-GSC-02	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH001	
164	DI	SCREEN TRAIN 2 INLET CHANNEL GATE CLOSED	H-SCR-GSC-02	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH001	
165	DI	SCREEN TRAIN 2 INLET CHANNEL GATE FAILED	H-SCR-GSC-02	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH001	
166	DI	SCREEN TRAIN 2 INLET CHANNEL GATE IN REMOTE	H-SCR-GSC-02	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH001	
167	DO	SCREEN TRAIN 2 INLET CHANNEL GATE OPEN CMD	H-SCR-GSC-02	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH001	
168	DI	SCREEN TRAIN 2 INLET CHANNEL GATE OPENED	H-SCR-GSC-02	ICWRC PLC - HEADWORKS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH001	
169	DI	BELT CONVEYOR RESET	H-SCR-	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	No	IH002	EXISTING
170	DI	BELT CONVEYOR RUNNING	H-SCR-	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH002	EXISTING
171	DI	BELT CONVEYOR FAILED	H-SCR-	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH002	EXISTING
172	DI	BELT CONVEYOR EMERGENCY STOPPED	H-SCR-	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH002	EXISTING
173	DO	COARSE SCREEN NO.1 DISCHARGE CHANNEL GATE OPEN CMD	H-SCR-GSC-11	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH002	EXISTING
174	DO	COARSE SCREEN NO.1 DISCHARGE CHANNEL GATE CLOSE CMD	H-SCR-GSC-11	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH002	EXISTING
175	DI	COARSE SCREEN NO.1 DISCHARGE CHANNEL GATE CLOSED	H-SCR-GSC-11	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH002	EXISTING
176	DI	COARSE SCREEN NO.1 DISCHARGE CHANNEL GATE OPENED	H-SCR-GSC-11	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH002	EXISTING
177	DI	COARSE SCREEN NO.1 DISCHARGE CHANNEL GATE IN REMOTE	H-SCR-GSC-11	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	No	IH002	EXISTING
178	DI	COARSE SCREEN NO.1 DISCHARGE CHANNEL GATE FAILED	H-SCR-GSC-11	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH002	EXISTING
179	DI	COARSE SCREEN NO. 1 EMERGENCY STOPPED	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH002	
180	DI	COARSE SCREEN NO. 1 FAILED	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH002	
181	DI	COARSE SCREEN NO. 1 HOME POSITION	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	POSITION	PLC	No	IH002	
182	DI	COARSE SCREEN NO. 1 IN REMOTE	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH002	
183	DI	COARSE SCREEN NO. 1 LEVEL HIGH	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IH002	
184	DI	COARSE SCREEN NO. 1 MOTOR HIGH TORQUE	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IH002	
185	DI	COARSE SCREEN NO. 1 RUNNING	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH002	
186	AO	COARSE SCREEN NO. 1 SPEED CONTROL	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH002	
187	AI	COARSE SCREEN NO. 1 SPEED INDICATION	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH002	
188	DI	COARSE SCREEN NO. 1 VFD FAULT	H-SCR-LCP-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH002	
189	AI	COARSE SCREEN NO. 1 DIFFERENTIAL LEVEL	H-SCR-LDIT-10	ICWRC PLC - SCREENS TRAIN 1	4-20 mA DC	0 - XX FT	2-WIRE	N/A	N/A	N/A	N/A	IH002	
190	DO	COARSE SCREEN NO.1 RUN CMD	H-SCR-SCRA-10	ICWRC PLC - SCREENS TRAIN 1	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH002	
191	DI	BELT CONVEYOR RESET	H-SCR-	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	No	IH003	EXISTING
192	DI	BELT CONVEYOR RUNNING	H-SCR-	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH003	EXISTING
193	DI	BELT CONVEYOR FAILED	H-SCR-	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH003	EXISTING
194	DI	BELT CONVEYOR EMERGENCY STOPPED	H-SCR-	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH003	EXISTING
195	DO	COARSE SCREEN NO.2 DISCHARGE CHANNEL GATE OPEN CMD	H-SCR-GSC-21	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH003	EXISTING
196	DO	COARSE SCREEN NO.2 DISCHARGE CHANNEL GATE CLOSE CMD	H-SCR-GSC-21	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH003	EXISTING
197	DI	COARSE SCREEN NO.2 DISCHARGE CHANNEL GATE CLOSED	H-SCR-GSC-21	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH003	EXISTING
198	DI	COARSE SCREEN NO.2 DISCHARGE CHANNEL GATE OPENED	H-SCR-GSC-21	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH003	EXISTING
199	DI	COARSE SCREEN NO.2 DISCHARGE CHANNEL GATE IN REMOTE	H-SCR-GSC-21	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	No	IH003	EXISTING
200	DI	COARSE SCREEN NO.2 DISCHARGE CHANNEL GATE FAILED	H-SCR-GSC-21	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH003	EXISTING
201	AI	COARSE SCREEN NO.2 DIFFERENTIAL LEVEL	H-SCR-LDIT-20	ICWRC PLC - SCREENS TRAIN 2	4-20 mA DC	0 - XX FT	2-WIRE	N/A	N/A	N/A	N/A	IH003	
202	AI	COARSE SCREEN NO.2 SPEED INDICATION	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH003	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
203	AO	COARSE SCREEN NO.2 SPEED CONTROL	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH003	
204	DI	COARSE SCREEN NO.2 IN REMOTE	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH003	
205	DI	COARSE SCREEN NO.2 RUNNING	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH003	
206	DI	COARSE SCREEN NO.2 LEVEL HIGH	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IH003	
207	DI	COARSE SCREEN NO.2 HOME POSITION	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	POSITION	PLC	No	IH003	
208	DI	COARSE SCREEN NO.2 EMERGENCY STOPPED	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH003	
209	DI	COARSE SCREEN NO.2 MOTOR HIGH TORQUE	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IH003	
210	DI	COARSE SCREEN NO.2 VFD FAULT	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH003	
211	DI	COARSE SCREEN NO.2 FAILED	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH003	
212	DO	COARSE SCREEN NO.2 RUN CMD	H-SCR-SCRA-20	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH003	
213	DO	FINE SCREEN CONVEYOR NO.2 RESET	H-SCR-SCRA-60	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IH003	
214	DO	FINE SCREEN NO.2 RUN CMD	H-SCR-SCRA-60	ICWRC PLC - SCREENS TRAIN 2	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH003	
215	DI	FINE SCREEN CONVEYOR NO.3 EMERGENCY STOPPED	H-SCR-COS-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH004	
216	DI	FINE SCREEN CONVEYOR NO.3 RUNNING	H-SCR-COS-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH004	
217	DI	FINE SCREEN CONVEYOR NO.3 FAILED	H-SCR-COS-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH004	
218	AI	COARSE SCREEN NO.3 DIFFERENTIAL LEVEL	H-SCR-LDIT-30	ICWRC PLC - SCREENS TRAIN 3	4-20 mA DC	0 - XX FT	2-WIRE	N/A	N/A	N/A	N/A	IH004	
219	AI	FINE SCREEN NO.3 DIFFERENTIAL LEVEL	H-SCR-LDIT-70	ICWRC PLC - SCREENS TRAIN 3	4-20 mA DC	0 - XX FT	2-WIRE	N/A	N/A	N/A	N/A	IH004	
220	AI	COARSE SCREEN NO.3 SPEED INDICATION	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH004	
221	AO	COARSE SCREEN NO.3 SPEED CONTROL	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH004	
222	DI	COARSE SCREEN NO.3 IN REMOTE	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH004	
223	DI	COARSE SCREEN NO.3 RUNNING	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH004	
224	DI	COARSE SCREEN NO.3 LEVEL HIGH	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IH004	
225	DI	COARSE SCREEN NO.3 HOME POSITION	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	POSITION	PLC	No	IH004	
226	DI	COARSE SCREEN NO.3 EMERGENCY STOPPED	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH004	
227	DI	COARSE SCREEN NO.3 MOTOR HIGH TORQUE	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IH004	
228	DI	COARSE SCREEN NO.3 VFD FAULT	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH004	
229	DI	COARSE SCREEN NO.3 FAILED	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH004	
230	DO	COARSE SCREEN NO.3 RUN CMD	H-SCR-SCRA-30	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH004	
231	AI	FINE SCREEN NO.3 SPEED INDICATION	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH004	
232	AO	FINE SCREEN NO.3 SPEED CONTROL	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH004	
233	DI	FINE SCREEN NO.3 EMERGENCY STOPPED	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	STOPPED	PLC	No	IH004	
234	DI	FINE SCREEN NO.3 IN REMOTE	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH004	
235	DI	FINE SCREEN NO.3 FAILED	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH004	
236	DI	FINE SCREEN NO.3 RUNNING	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH004	
237	DI	FINE SCREEN NO.3 VFD FAULT	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH004	
238	DI	FINE SCREEN NO.3 LEVEL HIGH	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IH004	
239	DO	FINE SCREEN CONVEYOR NO.3 RESET	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IH004	
240	DO	FINE SCREEN NO.3 RUN CMD	H-SCR-SCRA-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH004	
241	DO	FINE SCREEN NO.3 PRESS ZONE WASH WATER VALVE OPEN	H-SCR-VGB-70	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH004	
242	DO	FINE SCREEN NO.3 WASH ZONE NO.2 VALVE OPEN	H-SCR-VGB-71	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH004	
243	DO	FINE SCREEN NO.3 WASH ZONE NO.1 VALVE OPEN	H-SCR-VGB-72	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH004	
244	DO	FINE SCREEN NO.3 SPRAY BAR WASH WATER VALVE OPEN	H-SCR-VGB-73	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH004	
245	DO	FINE SCREEN NO.3 INTERNAL TANK WASH VALVE OPEN	H-SCR-VGB-74	ICWRC PLC - SCREENS TRAIN 3	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH004	
246	DI	FINE SCREEN CONVEYOR NO.4 EMERGENCY STOPPED	H-SCR-COS-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH005	
247	DI	FINE SCREEN CONVEYOR NO.4 RUNNING	H-SCR-COS-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH005	
248	DI	FINE SCREEN CONVEYOR NO.4 FAILED	H-SCR-COS-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH005	
249	AI	COARSE SCREEN NO.4 DIFFERENTIAL LEVEL	H-SCR-LDIT-40	ICWRC PLC - SCREENS TRAIN 4	4-20 mA DC	0 - XX FT	2-WIRE	N/A	N/A	N/A	N/A	IH005	
250	AI	FINE SCREEN NO.4 DIFFERENTIAL LEVEL	H-SCR-LDIT-80	ICWRC PLC - SCREENS TRAIN 4	4-20 mA DC	0 - XX FT	2-WIRE	N/A	N/A	N/A	N/A	IH005	
251	AI	COARSE SCREEN NO.4 SPEED INDICATION	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH005	
252	AO	COARSE SCREEN NO.4 SPEED CONTROL	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH005	
253	DI	COARSE SCREEN NO.4 IN REMOTE	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH005	
254	DI	COARSE SCREEN NO.4 RUNNING	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH005	
255	DI	COARSE SCREEN NO.4 LEVEL HIGH	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IH005	
256	DI	COARSE SCREEN NO.4 HOME POSITION	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	POSITION	PLC	No	IH005	
257	DI	COARSE SCREEN NO.4 EMERGENCY STOPPED	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH005	
258	DI	COARSE SCREEN NO.4 MOTOR HIGH TORQUE	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TORQUE	PLC	No	IH005	
259	DI	COARSE SCREEN NO.4 VFD FAULT	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH005	
260	DI	COARSE SCREEN NO.4 FAILED	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH005	
261	DO	COARSE SCREEN NO.4 RUN CMD	H-SCR-SCRA-40	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH005	
262	AI	FINE SCREEN NO.4 SPEED INDICATION	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH005	
263	AO	FINE SCREEN NO.4 SPEED CONTROL	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH005	
264	DI	FINE SCREEN NO.4 EMERGENCY STOPPED	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	STOPPED	PLC	No	IH005	
265	DI	FINE SCREEN NO.4 IN REMOTE	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH005	
266	DI	FINE SCREEN NO.4 FAILED	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH005	
267	DI	FINE SCREEN NO.4 RUNNING	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH005	
268	DI	FINE SCREEN NO.4 VFD FAULT	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH005	
269	DI	FINE SCREEN NO.4 LEVEL HIGH	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IH005	
270	DO	FINE SCREEN CONVEYOR NO.4 RESET	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IH005	
271	DO	FINE SCREEN NO.4 RUN CMD	H-SCR-SCRA-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH005	
272	DO	FINE SCREEN NO.4 PRESS ZONE WASH WATER VALVE OPEN	H-SCR-VGB-80	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH005	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
273	DO	FINE SCREEN NO.4 WASH ZONE NO.2 VALVE OPEN	H-SCR-VGB-81	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH005	
274	DO	FINE SCREEN NO.4 WASH ZONE NO.1 VALVE OPEN	H-SCR-VGB-82	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH005	
275	DO	FINE SCREEN NO.4 SPRAY BAR WASH WATER VALVE OPEN	H-SCR-VGB-83	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH005	
276	DO	FINE SCREEN NO.4 INTERNAL TANK WASH VALVE OPEN	H-SCR-VGB-84	ICWRC PLC - SCREENS TRAIN 4	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH005	
277	DI	FLUIDZING VALVE IN REMOTE	H-SCR-VGL-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH006	
278	DO	FLUIDZING VALVE OPEN CMD	H-SCR-VGL-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH006	
279	DI	FLUIDZING VALVE IN REMOTE	H-SCR-VGL-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH006	
280	DO	FLUIDZING VALVE OPEN CMD	H-SCR-VGL-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH006	
281	DI	FLUIDZING VALVE IN REMOTE	H-SCR-VGL-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH006	
282	DO	FLUIDZING VALVE OPEN CMD	H-SCR-VGL-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH006	
283	DI	FLUIDZING VALVE IN REMOTE	H-SCR-VGL-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH006	
284	DO	FLUIDZING VALVE OPEN CMD	H-SCR-VGL-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN	PLC	Yes	IH006	
285	DI	GRIT PUMP NO.1 FAILED	H-GRT-GRTP-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH007	
286	DI	GRIT PUMP NO.1 IN REMOTE	H-GRT-GRTP-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
287	DO	GRIT PUMP NO.1 RUN CMD	H-GRT-GRTP-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH007	
288	DI	GRIT PUMP NO.1 RUNNING	H-GRT-GRTP-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH007	
289	AO	GRIT PUMP NO.1 SPEED CONTROL	H-GRT-GRTP-10	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH007	
290	DI	GRIT PUMP NO.1 VFD FAULT	H-GRT-GRTP-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH007	
291	AI	SDGS GRIT PUMP NO.1 SPEED INDICATION	H-GRT-GRTP-10	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH007	
292	DO	GRIT PUMP NO.2 RUN CMD	H-GRT-GRTP-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH007	
293	AI	GRIT PUMP NO.2 SPEED INDICATION	H-GRT-GRTP-20	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH007	
294	DI	GRIT PUMP NO.2 FAILED	H-GRT-GRTP-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH007	
295	DI	GRIT PUMP NO.2 IN REMOTE	H-GRT-GRTP-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
296	DI	GRIT PUMP NO.2 RUNNING	H-GRT-GRTP-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH007	
297	AO	GRIT PUMP NO.2 SPEED CONTROL	H-GRT-GRTP-20	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH007	
298	DI	GRIT PUMP NO.2 VFD FAULT	H-GRT-GRTP-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH007	
299	DI	DEWATERING UNIT NO.1 EMERGENCY STOP PUSH - PULL	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH007	
300	DI	DEWATERING UNIT NO.1 VFD DRIVE FAULT	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH007	
301	DI	DEWATERING UNIT NO.1 VFD DRIVE LOR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
302	DI	DEWATERING UNIT NO.1 VFD DRIVE RUNNING	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH007	
303	AI	DEWATERING UNIT NO.1 VFD DRIVE SPEED INDICATION	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH007	
304	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.1 FLUIDIZING VALVE OCR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
305	DO	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.1 FLUIDIZING VALVE OPEN CMD	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
306	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.1 FLUSHING VALVE OCR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
307	DO	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.1 FLUSHING VALVE OPEN CMD	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
308	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.2 DRAIN VALVE MOV OCR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
309	DO	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.2 DRAIN VALVE MOV OPEN CMD	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
310	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.2 FLUIDIZING VALVE OCR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
311	DO	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.2 FLUIDIZING VALVE OPEN CMD	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
312	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.2 FLUSHING VALVE OCR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
313	DO	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.2 FLUSHING VALVE OPEN CMD	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
314	DO	DEWATERING UNIT NO.1 WASHER SV OPEN CMD	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
315	DI	DEWATERING UNIT NO.1 WATER SV OCR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
316	DI	DEWATERING UNIT NO.1 WET-DRY-REMOTE SELECTOR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
317	DI	DEWATERING UNIT NO.1 ZERO SPEED SWITCH	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	SPEED	PLC	No	IH007	
318	AO	DEWATERING UNIT NO.1 VFD DRIVE SPEED CONTROL	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH007	
319	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.1 DRAIN VALVE MOV OCR IN REMOTE	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
320	DO	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.1 DRAIN VALVE MOV OPEN CMD	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
321	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.1 DRAIN VALVE MOV OPEN STATUS	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH007	
322	DI	DEWATERING UNIT NO.1 WASHER / CLASSIFIER NO.2 DRAIN VALVE MOV OPEN STATUS	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH007	
323	DI	GRIT SNAIL FAILED	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH007	
324	DI	GRIT SNAIL RUNNING	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH007	
325	DI	WASHER / CLASSIFIER NO. 1 IN AUTO	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-AUTO	PLC	No	IH007	
326	DI	WASHER / CLASSIFIER NO. 2 IN AUTO	H-GRT-GRV-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-AUTO	PLC	No	IH007	
327	DO	WASHER / CLASSIFIER NO. 1 RUN CMD	H-GRT-GWC-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH007	
328	DO	WASHER / CLASSIFIER NO. 1 & 2 REMOTE WET/DRY WEATHER SELECTION	H-GRT-GWC-10-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	SELECTED	PLC	Yes	IH007	
329	DO	WASHER / CLASSIFIER NO. 2 RUN CMD	H-GRT-GWC-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH007	
330	AI	GRIT PUMP NO.1 DISCHARGE PRESSURE	H-GRT-PIT-10	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mA DC	0 - XX PSI	2-WIRE	N/A	N/A	N/A	N/A	IH007	
331	AI	GRIT PUMP NO.2 DISCHARGE PRESSURE	H-GRT-PIT-20	ICWRC PLC - GRIT CLASSIFIER 1	4-20 mA DC	0 - XX PSI	2-WIRE	N/A	N/A	N/A	N/A	IH007	
332	DO	GRIT PUMP NO.1 SUCTION MOV CLOSE CMD	H-GRT-VPN-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH007	
333	DO	GRIT PUMP NO.1 SUCTION MOV OPEN CMD	H-GRT-VPN-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
334	DI	GRIT PUMP NO.1 SUCTION MOV CLOSED	H-GRT-VPN-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH007	
335	DI	GRIT PUMP NO.1 SUCTION MOV FAULT	H-GRT-VPN-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH007	
336	DI	GRIT PUMP NO.1 SUCTION MOV IN REMOTE	H-GRT-VPN-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	
337	DI	GRIT PUMP NO.1 SUCTION MOV OPEN	H-GRT-VPN-10	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH007	
338	DO	GRIT PUMP NO.2 SUCTION MOV CLOSE CMD	H-GRT-VPN-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH007	
339	DO	GRIT PUMP NO.2 SUCTION MOV OPEN CMD	H-GRT-VPN-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH007	
340	DI	GRIT PUMP NO.2 SUCTION MOV CLOSED	H-GRT-VPN-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH007	
341	DI	GRIT PUMP NO.2 SUCTION MOV FAULT	H-GRT-VPN-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH007	
342	DI	GRIT PUMP NO.2 SUCTION MOV IN REMOTE	H-GRT-VPN-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH007	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
343	DI	GRIT PUMP NO.2 SUCTION MOV OPEN	H-GRT-VPN-20	ICWRC PLC - GRIT CLASSIFIER 1	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH007	
344	AI	SDGSGRIT PUMP NO.3 SPEED INDICATION	H-GRT-GRTP-30	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH008	
345	AO	GRIT PUMP NO.3 SPEED CONTROL	H-GRT-GRTP-30	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH008	
346	DI	GRIT PUMP NO.3 FAILED	H-GRT-GRTP-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH008	
347	DI	GRIT PUMP NO.3 IN REMOTE	H-GRT-GRTP-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
348	DI	GRIT PUMP NO.3 RUNNING	H-GRT-GRTP-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH008	
349	DI	GRIT PUMP NO.3 VFD FAULT	H-GRT-GRTP-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH008	
350	DO	GRIT PUMP NO.3 RUN CMD	H-GRT-GRTP-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH008	
351	AI	GRIT PUMP NO.4 SPEED INDICATION	H-GRT-GRTP-40	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH008	
352	AO	GRIT PUMP NO.4 SPEED CONTROL	H-GRT-GRTP-40	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH008	
353	DI	GRIT PUMP NO.4 RUNNING	H-GRT-GRTP-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH008	
354	DI	GRIT PUMP NO.4 FAILED	H-GRT-GRTP-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH008	
355	DI	GRIT PUMP NO.4 IN REMOTE	H-GRT-GRTP-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
356	DI	GRIT PUMP NO.4 VFD FAULT	H-GRT-GRTP-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH008	
357	DO	GRIT PUMP NO.4 RUN CMD	H-GRT-GRTP-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH008	
358	AI	DEWATERING UNIT NO.2 VFD DRIVE SPEED INDICATION	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IH008	
359	AO	DEWATERING UNIT NO.2 VFD DRIVE SPEED CONTROL	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IH008	
360	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.2 FLUSHING VALVE OCR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
361	DI	GRIT SNAIL FAILED	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IH008	
362	DI	GRIT SNAIL RUNNING	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH008	
363	DI	DEWATERING UNIT NO.2 WATER SV OCR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
364	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.1 FLUSHING VALVE OCR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
365	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.1 DRAIN VALVE MOV OCR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
366	DI	WASHER / CLASSIFIER NO. 3 IN AUTO	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-AUTO	PLC	No	IH008	
367	DI	DEWATERING UNIT NO.2 VFD DRIVE FAULT	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH008	
368	DI	DEWATERING UNIT NO.2 ZERO SPEED SWITCH	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	SPEED	PLC	No	IH008	
369	DI	WASHER / CLASSIFIER NO. 4 IN AUTO	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-AUTO	PLC	No	IH008	
370	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.1 DRAIN VALVE MOV OPEN STATUS	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH008	
371	DI	DEWATERING UNIT NO.2 WET-DRY-REMOTE SELECTOR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
372	DI	DEWATERING UNIT NO.2 VFD DRIVE RUNNING	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IH008	
373	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.1 FLUIDIZING VALVE OCR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
374	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.2 DRAIN VALVE MOV OCR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
375	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.2 FLUIDIZING VALVE OCR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
376	DI	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.2 DRAIN VALVE MOV OPEN STATUS	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH008	
377	DI	DEWATERING UNIT NO.2 EMERGENCY STOP PUSH - PULL	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IH008	
378	DI	DEWATERING UNIT NO.2 VFD DRIVE LOR IN REMOTE	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
379	DO	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.1 FLUSHING VALVE OPEN CMD	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
380	DO	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.2 FLUIDIZING VALVE OPEN CMD	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
381	DO	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.1 FLUIDIZING VALVE OPEN CMD	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
382	DO	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.2 FLUSHING VALVE OPEN CMD	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
383	DO	DEWATERING UNIT NO.2 WASHER SV OPEN CMD	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
384	DO	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.1 DRAIN VALVE MOV OPEN CMD	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
385	DO	DEWATERING UNIT NO.2 WASHER / CLASSIFIER NO.2 DRAIN VALVE MOV OPEN CMD	H-GRT-GRV-20	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
386	DO	WASHER / CLASSIFIER NO. 3 RUN CMD	H-GRT-GWC-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH008	
387	DO	WASHER / CLASSIFIER NO. 3 & 4 REMOTE WET/DRY WEATHER SELECTION	H-GRT-GWC-30-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	SELECTED	PLC	Yes	IH008	
388	DO	WASHER / CLASSIFIER NO. 4 RUN CMD	H-GRT-GWC-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IH008	
389	AI	GRIT PUMP NO.3 DISCHARGE PRESSURE	H-GRT-PIT-30	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mA DC	0 - XX PSI	2-WIRE	N/A	N/A	N/A	N/A	IH008	
390	AI	GRIT PUMP NO.4 DISCHARGE PRESSURE	H-GRT-PIT-40	ICWRC PLC - GRIT CLASSIFIER 2	4-20 mA DC	0 - XX PSI	2-WIRE	N/A	N/A	N/A	N/A	IH008	
391	DI	GRIT PUMP NO.3 SUCTION MOV IN REMOTE	H-GRT-VPN-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
392	DI	GRIT PUMP NO.3 SUCTION MOV OPEN	H-GRT-VPN-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH008	
393	DI	GRIT PUMP NO.3 SUCTION MOV FAULT	H-GRT-VPN-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH008	
394	DI	GRIT PUMP NO.3 SUCTION MOV CLOSED	H-GRT-VPN-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH008	
395	DO	GRIT PUMP NO.3 SUCTION MOV CLOSE CMD	H-GRT-VPN-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH008	
396	DO	GRIT PUMP NO.3 SUCTION MOV OPEN CMD	H-GRT-VPN-30	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
397	DI	GRIT PUMP NO.4 SUCTION MOV OPEN	H-GRT-VPN-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IH008	
398	DI	GRIT PUMP NO.4 SUCTION MOV FAULT	H-GRT-VPN-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IH008	
399	DI	GRIT PUMP NO.4 SUCTION MOV CLOSED	H-GRT-VPN-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	No	IH008	
400	DI	GRIT PUMP NO.4 SUCTION MOV IN REMOTE	H-GRT-VPN-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IH008	
401	DO	GRIT PUMP NO.4 SUCTION MOV OPEN CMD	H-GRT-VPN-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IH008	
402	DO	GRIT PUMP NO.4 SUCTION MOV CLOSE CMD	H-GRT-VPN-40	ICWRC PLC - GRIT CLASSIFIER 2	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IH008	
403	AI	EQ TANK TRANSFER PUMPS COMMON DISCHARGE FLOW	P-PRS-FIT-20	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IP001	
404	DI	EQ TANK TRANSFER PUMP NO.1 MOISTURE INTRUSION	P-PRS-MSH-10	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP001	
405	DI	EQ TANK TRANSFER PUMP NO.2 MOISTURE INTRUSION	P-PRS-MSH-20	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP001	
406	DI	EQ TANK TRANSFER PUMP NO.3 MOISTURE INTRUSION	P-PRS-MSH-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP001	
407	DI	EQ TANK TRANSFER PUMP NO.4 MOISTURE INTRUSION	P-PRS-MSH-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP001	
408	DI	EQ TANK TRANSFER PUMP NO.1 CHECK VALVE OPENED	P-PRS-PCL-10	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP001	
409	DI	EQ TANK TRANSFER PUMP NO.1 FAILED	P-PRS-PCL-10	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP001	
410	DO	EQ TANK TRANSFER PUMP NO.1 RESET	P-PRS-PCL-10	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP001	
411	DO	EQ TANK TRANSFER PUMP NO.1 RUN CMD	P-PRS-PCL-10	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP001	
412	DI	EQ TANK TRANSFER PUMP NO.1 RUNNING	P-PRS-PCL-10	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP001	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
413	DI	EQ TANK TRANSFER PUMP NO.1 VFD IN REMOTE	P-PRS-PCL-10	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP001	
414	DI	EQ TANK TRANSFER PUMP NO.2 CHECK VALVE OPENED	P-PRS-PCL-20	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP001	
415	DI	EQ TANK TRANSFER PUMP NO.2 FAILED	P-PRS-PCL-20	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP001	
416	DO	EQ TANK TRANSFER PUMP NO.2 RESET	P-PRS-PCL-20	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP001	
417	DO	EQ TANK TRANSFER PUMP NO.2 RUN CMD	P-PRS-PCL-20	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP001	
418	DI	EQ TANK TRANSFER PUMP NO.2 RUNNING	P-PRS-PCL-20	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP001	
419	DI	EQ TANK TRANSFER PUMP NO.2 VFD IN REMOTE	P-PRS-PCL-20	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP001	
420	DI	EQ TANK TRANSFER PUMP NO.3 CHECK VALVE OPEN	P-PRS-PCL-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP001	
421	DI	EQ TANK TRANSFER PUMP NO.3 FAILED	P-PRS-PCL-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP001	
422	DO	EQ TANK TRANSFER PUMP NO.3 RESET	P-PRS-PCL-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP001	
423	DO	EQ TANK TRANSFER PUMP NO.3 RUN CMD	P-PRS-PCL-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP001	
424	DI	EQ TANK TRANSFER PUMP NO.3 RUNNING	P-PRS-PCL-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP001	
425	DI	EQ TANK TRANSFER PUMP NO.3 VFD IN REMOTE	P-PRS-PCL-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP001	
426	DI	EQ TANK TRANSFER PUMP NO.4 CHECK VALVE OPENED	P-PRS-PCL-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP001	
427	DI	EQ TANK TRANSFER PUMP NO.4 FAILED	P-PRS-PCL-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP001	
428	DO	EQ TANK TRANSFER PUMP NO.4 RESET	P-PRS-PCL-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP001	
429	DO	EQ TANK TRANSFER PUMP NO.4 RUN CMD	P-PRS-PCL-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP001	
430	DI	EQ TANK TRANSFER PUMP NO.4 RUNNING	P-PRS-PCL-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP001	
431	DI	EQ TANK TRANSFER PUMP NO.4 VFD IN REMOTE	P-PRS-PCL-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP001	
432	AI	TRANSFER PUMPING STATION WETWELL LEVEL	P-RPS-LIT-20	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IP001	
433	DI	TRANSFER PUMPING STATION LEVEL HIGH	P-RPS-LSH-21	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IP001	
434	DI	TRANSFER PUMPING STATION LEVEL LOW	P-RPS-LSL-21	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL LOW	PLC	No	IP001	
435	AO	EQ TANK TRANSFER PUMP NO.1 SPEED CONTROL	P-RPS-PCL-10	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP001	
436	AI	EQ TANK TRANSFER PUMP NO.1 SPEED INDICATION	P-RPS-PCL-10	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP001	
437	AO	EQ TANK TRANSFER PUMP NO.2 SPEED CONTROL	P-RPS-PCL-20	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP001	
438	AI	EQ TANK TRANSFER PUMP NO.2 SPEED INDICATION	P-RPS-PCL-20	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP001	
439	AO	EQ TANK TRANSFER PUMP NO.3 SPEED CONTROL	P-RPS-PCL-30	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP001	
440	AI	EQ TANK TRANSFER PUMP NO.3 SPEED INDICATION	P-RPS-PCL-30	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP001	
441	AO	EQ TANK TRANSFER PUMP NO.4 SPEED CONTROL	P-RPS-PCL-40	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP001	
442	AI	EQ TANK TRANSFER PUMP NO.4 SPEED INDICATION	P-RPS-PCL-40	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP001	
443	AI	EQ TANK TRANSFER PUMP PRESSURE	P-RPS-PIT-20	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX PSI	2-WIRE	N/A	N/A	N/A	N/A	IP001	
444	DI	UPS POWER ALARM	P-RPS-XXX-XX	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	POWER ALARM	PLC	No	IP001	
445	DI	UPS FAULT	P-RPS-XXX-XX	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IP001	
446	AI	H2S GAS CONCENTRATION	P-PRS-AIT-30	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX PPM	4-WIRE	N/A	N/A	N/A	N/A	IP002	
447	DI	H2S GAS CONCENTRATION HIGH	P-PRS-AIT-30	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	CONCENTRATION HIGH	PLC	No	IP002	
448	AI	METHANE GAS CONCENTRATION	P-PRS-AIT-40	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX PPM	4-WIRE	N/A	N/A	N/A	N/A	IP002	
449	DI	METHANE GAS CONCENTRATION HIGH	P-PRS-AIT-40	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	CONCENTRATION HIGH	PLC	No	IP002	
450	AI	H2S GAS CONCENTRATION	P-PRS-AIT-50	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX PPM	4-WIRE	N/A	N/A	N/A	N/A	IP002	
451	DI	H2S GAS CONCENTRATION HIGH	P-PRS-AIT-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	CONCENTRATION HIGH	PLC	No	IP002	
452	AI	METHANE GAS CONCENTRATION	P-PRS-AIT-60	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX PPM	4-WIRE	N/A	N/A	N/A	N/A	IP002	
453	DI	METHANE GAS CONCENTRATION HIGH	P-PRS-AIT-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	CONCENTRATION HIGH	PLC	No	IP002	
454	DI	HVAC VENTILATION SYSTEM FAILURE	P-PRS-LCP-XX	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	
455	AI	TRANSFER PUMPING STATION WETWELL LEVEL	P-PRS-LIT-40	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX FT	4-WIRE	N/A	N/A	N/A	N/A	IP002	
456	DI	TRANSFER PUMPING STATION LEVEL HIGH	P-PRS-LSH-41	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL HIGH	PLC	No	IP002	
457	DI	TRANSFER PUMPING STATION LEVEL LOW	P-PRS-LSL-42	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL LOW	PLC	No	IP002	
458	DI	SRWRC NO. 1 MOISTURE INTRUSION	P-PRS-MSH-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
459	DI	SRWRC NO. 2 MOISTURE INTRUSION	P-PRS-MSH-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
460	DI	SRWRC NO. 3 MOISTURE INTRUSION	P-PRS-MSH-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
461	DI	SRWRC NO. 4 MOISTURE INTRUSION	P-PRS-MSH-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
462	DI	SRWRC NO. 5 MOISTURE INTRUSION	P-PRS-MSH-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
463	DI	SRWRC NO. 6 MOISTURE INTRUSION	P-PRS-MSH-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
464	DI	EQ TANK TRANSFER PUMP NO.5 MOISTURE INTRUSION	P-PRS-MSH-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
465	DI	EQ TANK TRANSFER PUMP NO.6 MOISTURE INTRUSION	P-PRS-MSH-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH MOISTURE	PLC	No	IP002	
466	DI	SRWRC NO. 1 CHECK VALVE OPENED	P-PRS-PCL-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	
467	DI	SRWRC NO. 1 FAILED	P-PRS-PCL-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	
468	DO	SRWRC NO. 1 RESET	P-PRS-PCL-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	
469	DO	SRWRC NO. 1 RUN CMD	P-PRS-PCL-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	
470	DI	SRWRC NO. 1 RUNNING	P-PRS-PCL-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	
471	DI	SRWRC NO. 1 VFD FAULT	P-PRS-PCL-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IP002	
472	DI	SRWRC NO. 1 VFD IN REMOTE	P-PRS-PCL-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	
473	DI	SRWRC NO. 2 CHECK VALVE OPENED	P-PRS-PCL-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	
474	DI	SRWRC NO. 2 FAILED	P-PRS-PCL-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	
475	DO	SRWRC NO. 2 RESET	P-PRS-PCL-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	
476	DO	SRWRC NO. 2 RUN CMD	P-PRS-PCL-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	
477	DI	SRWRC NO. 2 RUNNING	P-PRS-PCL-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	
478	DI	SRWRC NO. 2 VFD FAULT	P-PRS-PCL-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IP002	
479	DI	SRWRC NO. 2 VFD IN REMOTE	P-PRS-PCL-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	
480	DI	SRWRC NO. 3 CHECK VALVE OPENED	P-PRS-PCL-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	
481	DI	SRWRC NO. 3 FAILED	P-PRS-PCL-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	
482	DO	SRWRC NO. 3 RESET	P-PRS-PCL-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
483	DO	SRWRC NO. 3 RUN CMD	P-PRS-PCL-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	
484	DI	SRWRC NO. 3 RUNNING	P-PRS-PCL-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	
485	DI	SRWRC NO. 3 VFD FAULT	P-PRS-PCL-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IP002	
486	DI	SRWRC NO. 3 VFD IN REMOTE	P-PRS-PCL-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	
487	DI	SRWRC NO. 4 CHECK VALVE OPENED	P-PRS-PCL-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	
488	DI	SRWRC NO. 4 FAILED	P-PRS-PCL-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	
489	DO	SRWRC NO. 4 RESET	P-PRS-PCL-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	
490	DO	SRWRC NO. 4 RUN CMD	P-PRS-PCL-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	
491	DI	SRWRC NO. 4 RUNNING	P-PRS-PCL-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	
492	DI	SRWRC NO. 4 VFD FAULT	P-PRS-PCL-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IP002	
493	DI	SRWRC NO. 4 VFD IN REMOTE	P-PRS-PCL-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	
494	DI	SRWRC NO. 5 CHECK VALVE OPENED	P-PRS-PCL-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	FUTURE
495	DI	SRWRC NO. 5 FAILED	P-PRS-PCL-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	FUTURE
496	DO	SRWRC NO. 5 RESET	P-PRS-PCL-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	FUTURE
497	DO	SRWRC NO. 5 RUN CMD	P-PRS-PCL-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	FUTURE
498	DI	SRWRC NO. 5 RUNNING	P-PRS-PCL-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	FUTURE
499	DI	SRWRC NO. 5 VFD FAULT	P-PRS-PCL-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IP002	FUTURE
500	DI	SRWRC NO. 5 VFD IN REMOTE	P-PRS-PCL-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	FUTURE
501	DI	SRWRC NO. 6 CHECK VALVE OPENED	P-PRS-PCL-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	FUTURE
502	DI	SRWRC NO. 6 FAILED	P-PRS-PCL-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	FUTURE
503	DO	SRWRC NO. 6 RESET	P-PRS-PCL-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	FUTURE
504	DO	SRWRC NO. 6 RUN CMD	P-PRS-PCL-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	FUTURE
505	DI	SRWRC NO. 6 RUNNING	P-PRS-PCL-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	FUTURE
506	DI	SRWRC NO. 6 VFD FAULT	P-PRS-PCL-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IP002	FUTURE
507	DI	SRWRC NO. 6 VFD IN REMOTE	P-PRS-PCL-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	FUTURE
508	DI	EQ TANK TRANSFER PUMP NO.5 CHECK VALVE OPENED	P-PRS-PCL-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	
509	DI	EQ TANK TRANSFER PUMP NO.5 FAILED	P-PRS-PCL-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	
510	DO	EQ TANK TRANSFER PUMP NO.5 RESET	P-PRS-PCL-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	
511	DO	EQ TANK TRANSFER PUMP NO.5 RUN CMD	P-PRS-PCL-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	
512	DI	EQ TANK TRANSFER PUMP NO.5 RUNNING	P-PRS-PCL-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	
513	DI	EQ TANK TRANSFER PUMP NO.5 VFD IN REMOTE	P-PRS-PCL-50	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	
514	DI	EQ TANK TRANSFER PUMP NO.6 CHECK VALVE OPENED	P-PRS-PCL-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	No	IP002	
515	DI	EQ TANK TRANSFER PUMP NO.6 FAILED	P-PRS-PCL-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IP002	
516	DO	EQ TANK TRANSFER PUMP NO.6 RESET	P-PRS-PCL-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IP002	
517	DO	EQ TANK TRANSFER PUMP NO.6 RUN CMD	P-PRS-PCL-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IP002	
518	DI	EQ TANK TRANSFER PUMP NO.6 RUNNING	P-PRS-PCL-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IP002	
519	DI	EQ TANK TRANSFER PUMP NO.6 VFD IN REMOTE	P-PRS-PCL-60	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IP002	
520	AI	EQ TANK TRANSFER PUMP PRESSURE	P-PRS-PIT-20	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX PSI	2-WIRE	N/A	N/A	N/A	N/A	IP002	
521	DI	SRWRC NO. 1 HIGH MOTOR TEMP.	P-PRS-TSH-11	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IP002	
522	DI	SRWRC NO. 2 HIGH MOTOR TEMP.	P-PRS-TSH-12	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IP002	
523	DI	SRWRC NO. 3 HIGH MOTOR TEMP.	P-PRS-TSH-13	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IP002	
524	DI	SRWRC NO. 4 HIGH MOTOR TEMP.	P-PRS-TSH-14	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IP002	
525	DI	SRWRC NO. 5 HIGH MOTOR TEMP.	P-PRS-TSH-15	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IP002	FUTURE
526	DI	SRWRC NO. 6 HIGH MOTOR TEMP.	P-PRS-TSH-16	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	HIGH TEMP.	PLC	No	IP002	FUTURE
527	AI	ELECTRICAL ROOM TEMPERATURE	P-PRS-TT-10	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - XX DEG. F	2-WIRE	N/A	N/A	N/A	N/A	IP002	
528	AO	SRWRC NO. 1 SPEED CONTROL	P-RPS-PCL-11	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	
529	AI	SRWRC NO. 1 SPEED INDICATION	P-RPS-PCL-11	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	
530	AO	SRWRC NO. 2 SPEED CONTROL	P-RPS-PCL-12	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	
531	AI	SRWRC NO. 2 SPEED INDICATION	P-RPS-PCL-12	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	
532	AO	SRWRC NO. 3 SPEED CONTROL	P-RPS-PCL-13	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	
533	AI	SRWRC NO. 3 SPEED INDICATION	P-RPS-PCL-13	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	
534	AO	SRWRC NO. 4 SPEED CONTROL	P-RPS-PCL-14	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	
535	AI	SRWRC NO. 4 SPEED INDICATION	P-RPS-PCL-14	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	
536	AO	SRWRC NO. 5 SPEED CONTROL	P-RPS-PCL-15	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	FUTURE
537	AI	SRWRC NO. 5 SPEED INDICATION	P-RPS-PCL-15	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	FUTURE
538	AO	SRWRC NO. 6 SPEED CONTROL	P-RPS-PCL-16	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	FUTURE
539	AI	SRWRC NO. 6 SPEED INDICATION	P-RPS-PCL-16	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	FUTURE
540	AO	EQ TANK TRANSFER PUMP NO.5 SPEED CONTROL	P-RPS-PCL-50	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	
541	AI	EQ TANK TRANSFER PUMP NO.5 SPEED INDICATION	P-RPS-PCL-50	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	
542	AO	EQ TANK TRANSFER PUMP NO.6 SPEED CONTROL	P-RPS-PCL-60	ICWRC PLC - TRANSFER PS	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IP002	
543	AI	EQ TANK TRANSFER PUMP NO.6 SPEED INDICATION	P-RPS-PCL-60	ICWRC PLC - TRANSFER PS	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IP002	
544	DI	FIRE ALARM SYSTEM ALARM	P-RPS-XXX-XX	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	ALARM	PLC	No	IP002	
545	DI	FIRE ALARM SYSTEM IN TROUBLE	P-RPS-XXX-XX	ICWRC PLC - TRANSFER PS	N/A	N/A	N/A	24VDC OR 120VAC	IN TROUBLE	PLC	No	IP002	
546	DI	SLUDGE GRINNDER PUMP NO. 1 EMERGENCY STOP PRESSED	R-PRC-GRD-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IR001	EXISTING
547	DI	SLUDGE GRINNDER PUMP NO. 1 IN REMOTE	R-PRC-GRD-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR001	EXISTING
548	DI	SLUDGE GRINNDER PUMP NO. 1 RUNNING	R-PRC-GRD-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR001	EXISTING
549	DI	SLUDGE GRINNDER PUMP NO. 1 FAILED	R-PRC-GRD-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR001	EXISTING
550	DO	SLUDGE GRINNDER PUMP NO. 1 RESET	R-PRC-GRD-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR001	EXISTING
551	DO	SLUDGE GRINNDER PUMP NO. 1 RUN CMD	R-PRC-GRD-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR001	EXISTING
552	DI	SLUDGE GRINNDER PUMP NO. 2 EMERGENCY STOP PRESSED	R-PRC-GRD-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IR001	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
553	DI	SLUDGE GRINNDER PUMP NO. 2 IN REMOTE	R-PRC-GRD-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR001	
554	DI	SLUDGE GRINNDER PUMP NO. 2 RUNNING	R-PRC-GRD-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR001	
555	DI	SLUDGE GRINNDER PUMP NO. 2 FAILED	R-PRC-GRD-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR001	
556	DO	SLUDGE GRINNDER PUMP NO. 2 RESET	R-PRC-GRD-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR001	
557	DO	SLUDGE GRINNDER PUMP NO. 2 RUN CMD	R-PRC-GRD-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR001	
558	DI	SLUDGE GRINNDER PUMP NO. 3 EMERGENCY STOP PRESSED	R-PRC-GRD-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IR001	
559	DI	SLUDGE GRINNDER PUMP NO. 3 IN REMOTE	R-PRC-GRD-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR001	
560	DI	SLUDGE GRINNDER PUMP NO. 3 RUNNING	R-PRC-GRD-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR001	
561	DI	SLUDGE GRINNDER PUMP NO. 3 FAILED	R-PRC-GRD-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR001	
562	DO	SLUDGE GRINNDER PUMP NO. 3 RESET	R-PRC-GRD-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR001	
563	DO	SLUDGE GRINNDER PUMP NO. 3 RUN CMD	R-PRC-GRD-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR001	
564	DI	SLUDGE GRINNDER PUMP NO. 4 EMERGENCY STOP PRESSED	R-PRC-GRD-40	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	EMERGENCY STOPPED	PLC	No	IR001	
565	DI	SLUDGE GRINNDER PUMP NO. 4 IN REMOTE	R-PRC-GRD-40	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR001	
566	DI	SLUDGE GRINNDER PUMP NO. 4 RUNNING	R-PRC-GRD-40	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR001	
567	DI	SLUDGE GRINNDER PUMP NO. 4 FAILED	R-PRC-GRD-40	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR001	
568	DO	SLUDGE GRINNDER PUMP NO. 4 RESET	R-PRC-GRD-40	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR001	
569	DO	SLUDGE GRINNDER PUMP NO. 4 RUN CMD	R-PRC-GRD-40	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR001	
570	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 1 OPEN CMD	H-PRS-VPL-R21	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IR002	
571	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 1 CLOSE CMD	H-PRS-VPL-R21	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IR002	
572	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 1 CLOSED	H-PRS-VPL-R21	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	NO	IR002	
573	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 1 OPENED	H-PRS-VPL-R21	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	NO	IR002	
574	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 1 IN REMOTE	H-PRS-VPL-R21	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	NO	IR002	
575	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 1 FAILED	H-PRS-VPL-R21	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	NO	IR002	
576	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 2 OPEN CMD	H-PRS-VPL-R22	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IR002	
577	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 2 CLOSE CMD	H-PRS-VPL-R22	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IR002	
578	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 2 CLOSED	H-PRS-VPL-R22	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	NO	IR002	
579	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 2 OPENED	H-PRS-VPL-R22	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	NO	IR002	
580	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 2 IN REMOTE	H-PRS-VPL-R22	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	NO	IR002	
581	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 2 FAILED	H-PRS-VPL-R22	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	NO	IR002	
582	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 3 OPEN CMD	H-PRS-VPL-R23	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IR002	
583	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 3 CLOSE CMD	H-PRS-VPL-R23	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IR002	
584	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 3 CLOSED	H-PRS-VPL-R23	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	NO	IR002	
585	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 3 OPENED	H-PRS-VPL-R23	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	NO	IR002	
586	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 3 IN REMOTE	H-PRS-VPL-R23	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	NO	IR002	
587	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 3 FAILED	H-PRS-VPL-R23	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	NO	IR002	
588	AI	PRIMARY SLUDGE PUMP NO. 1 & 2 COMMON DISCHARGE FLOW	R-PRS-FIT-10R	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IR002	
589	AI	PRIMARY SLUDGE PUMP NO. 3 & 4 COMMON DISCHARGE FLOW	R-PRS-FIT-20R	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IR002	
590	AI	PRIMARY SLUDGE PUMP NO. 5 & 6 COMMON DISCHARGE FLOW	R-PRS-FIT-30R	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IR002	
591	DI	HVAC VENTILATION SYSTEM FAILURE	R-PRS-LCP-XX	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	SYSTEM FAILURE	PLC	No	IR002	
592	DI	PRIMARY SLUDGE PUMP NO.1 FAILED	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR002	FUTURE
593	DI	PRIMARY SLUDGE PUMP NO.1 HIGH PRESSURE	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR002	FUTURE
594	DI	PRIMARY SLUDGE PUMP NO.1 LEAK DETECTED	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR002	FUTURE
595	DO	PRIMARY SLUDGE PUMP NO.1 RESET	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR002	FUTURE
596	DI	PRIMARY SLUDGE PUMP NO.1 ROTATION SENSOR	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR002	FUTURE
597	DO	PRIMARY SLUDGE PUMP NO.1 RUN CMD	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR002	FUTURE
598	DI	PRIMARY SLUDGE PUMP NO.1 RUNNING	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR002	FUTURE
599	AO	PRIMARY SLUDGE PUMP NO.1 SPEED CONTROL	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR002	FUTURE
600	AI	PRIMARY SLUDGE PUMP NO.1 SPEED INDICATION	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR002	FUTURE
601	DI	PRIMARY SLUDGE PUMP NO.1 VFD FAULT	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR002	FUTURE
602	DI	PRIMARY SLUDGE PUMP NO.1 VFD IN REMOTE	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR002	FUTURE
603	DI	PRIMARY SLUDGE PUMP NO.1 OIL LEVEL	R-PRS-PPS-10	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR002	FUTURE
604	DI	PRIMARY SLUDGE PUMP NO.2 FAILED	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR002	
605	DI	PRIMARY SLUDGE PUMP NO.2 HIGH PRESSURE	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR002	
606	DI	PRIMARY SLUDGE PUMP NO.2 LEAK DETECTED	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR002	
607	DO	PRIMARY SLUDGE PUMP NO.2 RESET	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR002	
608	DI	PRIMARY SLUDGE PUMP NO.2 ROTATION SENSOR	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR002	
609	DO	PRIMARY SLUDGE PUMP NO.2 RUN CMD	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR002	
610	DI	PRIMARY SLUDGE PUMP NO.2 RUNNING	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR002	
611	AO	PRIMARY SLUDGE PUMP NO.2 SPEED CONTROL	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR002	
612	AI	PRIMARY SLUDGE PUMP NO.2 SPEED INDICATION	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR002	
613	DI	PRIMARY SLUDGE PUMP NO.2 VFD FAULT	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR002	
614	DI	PRIMARY SLUDGE PUMP NO.2 VFD IN REMOTE	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR002	
615	DI	PRIMARY SLUDGE PUMP NO.2 OIL LEVEL	R-PRS-PPS-20	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR002	
616	DI	PRIMARY SLUDGE PUMP NO.3 FAILED	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR002	
617	DI	PRIMARY SLUDGE PUMP NO.3 HIGH PRESSURE	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR002	
618	DI	PRIMARY SLUDGE PUMP NO.3 LEAK DETECTED	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR002	
619	DO	PRIMARY SLUDGE PUMP NO.3 RESET	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR002	
620	DI	PRIMARY SLUDGE PUMP NO.3 ROTATION SENSOR	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR002	
621	DO	PRIMARY SLUDGE PUMP NO.3 RUN CMD	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR002	
622	DI	PRIMARY SLUDGE PUMP NO.3 RUNNING	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR002	

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
623	AO	PRIMARY SLUDGE PUMP NO.3 SPEED CONTROL	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR002	
624	AI	PRIMARY SLUDGE PUMP NO.3 SPEED INDICATION	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR002	
625	DI	PRIMARY SLUDGE PUMP NO.3 VFD FAULT	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR002	
626	DI	PRIMARY SLUDGE PUMP NO.3 VFD IN REMOTE	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR002	
627	DI	PRIMARY SLUDGE PUMP NO.3 OIL LEVEL	R-PRS-PPS-30	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR002	
628	DI	PRIMARY SLUDGE PUMP NO.6 FAILED	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR002	
629	DI	PRIMARY SLUDGE PUMP NO.6 HIGH PRESSURE	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR002	
630	DI	PRIMARY SLUDGE PUMP NO.6 LEAK DETECTED	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR002	
631	DO	PRIMARY SLUDGE PUMP NO.6 RESET	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR002	
632	DI	PRIMARY SLUDGE PUMP NO.6 ROTATION SENSOR	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR002	
633	DO	PRIMARY SLUDGE PUMP NO.6 RUN CMD	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR002	
634	DI	PRIMARY SLUDGE PUMP NO.6 RUNNING	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR002	
635	AO	PRIMARY SLUDGE PUMP NO.6 SPEED CONTROL	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR002	
636	AI	PRIMARY SLUDGE PUMP NO.6 SPEED INDICATION	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR002	
637	DI	PRIMARY SLUDGE PUMP NO.6 VFD FAULT	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR002	
638	DI	PRIMARY SLUDGE PUMP NO.6 VFD IN REMOTE	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR002	
639	DI	PRIMARY SLUDGE PUMP NO.6 OIL LEVEL	R-PRS-PPS-60	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR002	
640	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 4 OPEN CMD	H-PRS-VPL-R24	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPEN CMD	PLC	Yes	IR003	
641	DO	PRI SLUDGE PUMPS DISCHARGE VALVE 4 CLOSE CMD	H-PRS-VPL-R24	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSE CMD	PLC	Yes	IR003	
642	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 4 CLOSED	H-PRS-VPL-R24	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	CLOSED	PLC	NO	IR003	
643	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 4 OPENED	H-PRS-VPL-R24	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	OPENED	PLC	NO	IR003	
644	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 4 IN REMOTE	H-PRS-VPL-R24	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN REMOTE	PLC	NO	IR003	
645	DI	PRI SLUDGE PUMPS DISCHARGE VALVE 4 FAILED	H-PRS-VPL-R24	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	NO	IR003	
646	AI	PRIMARY SLUDGE PUMP NO. 7 & 8 COMMON DISCHARGE FLOW	R-PRS-FIT-40R	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - XX GPM	4-WIRE	N/A	N/A	N/A	N/A	IR003	
647	DI	HVAC VENTILATION SYSTEM FAILURE	R-PRS-LCP-XX	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	SYSTEM FAILURE	PLC	No	IR003	
648	DI	DRAIN PUMP NO.1 FAILED	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR003	
649	DI	DRAIN PUMP NO.1 HIGH PRESSURE	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR003	
650	DI	DRAIN PUMP NO.1 LEAK DETECTED	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR003	
651	DO	DRAIN PUMP NO.1 RESET	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR003	
652	DI	DRAIN PUMP NO.1 ROTATION SENSOR	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR003	
653	DO	DRAIN PUMP NO.1 RUN CMD	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR003	
654	DI	DRAIN PUMP NO.1 RUNNING	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR003	
655	AO	DRAIN PUMP NO.1 SPEED CONTROL	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR003	
656	AI	DRAIN PUMP NO.1 SPEED INDICATION	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR003	
657	DI	DRAIN PUMP NO.1 VFD FAULT	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR003	
658	DI	DRAIN PUMP NO.1 VFD IN REMOTE	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR003	
659	DI	DRAIN PUMP NO.1 OIL LEVEL	R-PRS-PPS-11	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR003	
660	DI	DRAIN PUMP NO.2 FAILED	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR003	
661	DI	DRAIN PUMP NO.2 HIGH PRESSURE	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR003	
662	DI	DRAIN PUMP NO.2 LEAK DETECTED	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR003	
663	DO	DRAIN PUMP NO.2 RESET	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR003	
664	DI	DRAIN PUMP NO.2 ROTATION SENSOR	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR003	
665	DO	DRAIN PUMP NO.2 RUN CMD	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR003	
666	DI	DRAIN PUMP NO.2 RUNNING	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR003	
667	AO	DRAIN PUMP NO.2 SPEED CONTROL	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR003	
668	AI	DRAIN PUMP NO.2 SPEED INDICATION	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR003	
669	DI	DRAIN PUMP NO.1 VFD FAULT	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR003	
670	DI	DRAIN PUMP NO.1 VFD IN REMOTE	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR003	
671	DI	DRAIN PUMP NO.1 OIL LEVEL	R-PRS-PPS-12	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR003	
672	DI	PRIMARY SLUDGE PUMP NO.7 FAILED	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR003	
673	DI	PRIMARY SLUDGE PUMP NO.7 HIGH PRESSURE	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR003	
674	DI	PRIMARY SLUDGE PUMP NO.7 LEAK DETECTED	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR003	
675	DO	PRIMARY SLUDGE PUMP NO.7 RESET	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR003	
676	DI	PRIMARY SLUDGE PUMP NO.7 ROTATION SENSOR	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR003	
677	DO	PRIMARY SLUDGE PUMP NO.7 RUN CMD	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR003	
678	DI	PRIMARY SLUDGE PUMP NO.7 RUNNING	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR003	
679	AO	PRIMARY SLUDGE PUMP NO.7 SPEED CONTROL	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR003	
680	AI	PRIMARY SLUDGE PUMP NO.7 SPEED INDICATION	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR003	
681	DI	PRIMARY SLUDGE PUMP NO.7 VFD FAULT	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR003	
682	DI	PRIMARY SLUDGE PUMP NO.7 VFD IN REMOTE	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR003	
683	DI	PRIMARY SLUDGE PUMP NO.7 OIL LEVEL	R-PRS-PPS-70	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR003	
684	DI	PRIMARY SLUDGE PUMP NO.8 FAILED	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAILED	PLC	No	IR003	ADDITIVE ALTERNATIVE
685	DI	PRIMARY SLUDGE PUMP NO.8 HIGH PRESSURE	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	HIGH PRESSURE	PLC	No	IR003	ADDITIVE ALTERNATIVE
686	DI	PRIMARY SLUDGE PUMP NO.8 LEAK DETECTED	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEAK	PLC	No	IR003	ADDITIVE ALTERNATIVE

Item	Type	Description	Field Device	Controller ID or Rem I/O	Analog Signal Type	Analog Calibrated Range	Analog Power	Digital Signal Type	Digital Closed State	Digital Power Source	Digital Interp Relay	PID_DRAWING	Remarks
687	DO	PRIMARY SLUDGE PUMP NO.8 RESET	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RESET	PLC	Yes	IR003	ADDITIVE ALTERNATIVE
688	DI	PRIMARY SLUDGE PUMP NO.8 ROTATION SENSOR	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	ROTATION	PLC	No	IR003	ADDITIVE ALTERNATIVE
689	DO	PRIMARY SLUDGE PUMP NO.8 RUN CMD	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUN CMD	PLC	Yes	IR003	ADDITIVE ALTERNATIVE
690	DI	PRIMARY SLUDGE PUMP NO.8 RUNNING	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	RUNNING	PLC	No	IR003	ADDITIVE ALTERNATIVE
691	AO	PRIMARY SLUDGE PUMP NO.8 SPEED CONTROL	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	4-20 mADC	0-100%	2-WIRE	N/A	N/A	N/A	No	IR003	ADDITIVE ALTERNATIVE
692	AI	PRIMARY SLUDGE PUMP NO.8 SPEED INDICATION	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	4-20 mA DC	0 - 100%	2-WIRE	N/A	N/A	N/A	N/A	IR003	ADDITIVE ALTERNATIVE
693	DI	PRIMARY SLUDGE PUMP NO.8 VFD FAULT	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	FAULT	PLC	No	IR003	ADDITIVE ALTERNATIVE
694	DI	PRIMARY SLUDGE PUMP NO.8 VFD IN REMOTE	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	IN-REMOTE	PLC	No	IR003	ADDITIVE ALTERNATIVE
695	DI	PRIMARY SLUDGE PUMP NO.8 OIL LEVEL	R-PRS-PPS-80	SRWRC PLC - HEADHOUSE	N/A	N/A	N/A	24VDC OR 120VAC	LEVEL ALARM	PLC	No	IR003	ADDITIVE ALTERNATIVE

Section 17532

PICS DISTRIBUTED CONTROL SYSTEM

PART 1 - GENERAL

1-1. SCOPE.

This section covers the modifications and upgrades to an existing Distributed Control System (DCS) as designated herein, including associated input/output hardware to control process equipment and serves as the interface to field devices and PLC-based systems listed in Section 17500 and 17530.

The decommissioning of Intrenchment Creek Water Reclamation Center (ICWRC) with resultant pumping of untreated wastewater to the South River WRC (SRWRC) requires additional instrumentation and control systems located at ICWRC and SRWRC incorporating upgrades to existing ICWRC and SRWRC Foxboro DCS.

New 'stand-alone' PLC-based controls will be installed for all new equipment systems at ICWRC Headworks & ICWRC Transfer Pump Station. New 'stand-alone' PLC-based controls will be installed for all new equipment systems at SRWRC (Headhouse and Chemical Dosing PLC). PLC-based controls are referenced under 17500 and 17530. All new PLC-based controls will be interfaced to the existing ICWRC and SRWRC DCS systems via fiber-optic based Ethernet communications connected to Foxboro DCS enclosures (ICWRC PLC-gateway located in the ICWRC Power Generation Building, SRWRC PLC-gateways located in Preliminary Treatment Building and North Primary Sludge Pump Station).

1-1.01. ICWRC DCS System Improvements. Hardware and software upgrades shall be implemented on the existing ICWRC Foxboro DCS system (Administration Building) and DCS Fieldbus Modules (FBM's) within enclosures remaining in service upon project completion based on lifecycle status (obsolescence and future availability) of Foxboro DCS hardware and software products.

Existing major ICWRC Foxboro DCS components:

- 4 24-port fiber switches (the MESH network)
- 4 Workstations (all PC-based 'tower' hardware platforms, Microsoft XP operating system) designations (1 - H92B, 1 P91D, 1- P92F, 1-P91G)
  - Reports & Administration
  - Operator Workstation
  - Engineering Workstation

    - Operator Workstation
- 2 ZCP270 Control Processors
- 135 (Total) Fieldbus Modules.
    - 116 - Model 100 series (obsolete) Fieldbus Modules located at following process areas:

      Headworks, Digester Headhouse, Old Tunnel Pump House, Power Generation Building, Recirculation Pump Station, CSO Chemical Building, and the CSO Sludge Pump Room.
    - 19 - Model 200 series Fieldbus Modules.

Upgrades / Modifications. Conduct a comprehensive (field verified) inventory of ICWRC DCS hardware, software, and I/O to provide complete and accurate record documentation reflective of the existing system installation. The inventory shall include verification of all existing software control block functions utilized for remote manual and automatic control of ICWRC plant treatment processes.

Implement all measures (temporary and permanent) required to maintain ICWRC operational integrity during decommission and demolishment process of project designated equipment systems monitored and/or controlled by ICWRC Foxboro DCS.

Implement all measures (temporary and permanent) required to identify and migrate existing process equipment systems monitored and/or controlled by ICWRC Foxboro DCS that will remain in service during and after construction of new facilities.

Implement all measures (temporary and permanent) required to maintain ICWRC operational integrity during DCS I/O migration of existing I/O systems from Foxboro '100 series' I/O to '200 series' I/O.

Replace three (3) (Foxboro designation 'H92') operator workstations and one (1) (Foxboro designation 'H91') engineering workstation / server with (current Foxboro DCS hardware/software supported) computers and operating systems.

Upgrade 'H92' operator workstations and 'H91' engineering workstation / server to 'current supported release' of Foxboro DCS application software and supporting operator interface applications.

a. Administration Building - 'H91' workstation / server & 'H92' Operator Workstation
b. Filter Building – 'H92' Operator Workstation
c. Chemical Building – 'H92' Operator Workstation

Replacement of Foxboro DCS '100 Series' FBM's and processors with 200 Series FBM's and processors in the following (existing) locations:

d. Centrifuge Building
e. Power Generation Building
f. CSO Chemical Building
g. East Area CSO Sludge Pump Station
h. East Area CSO Tunnel Pump Station

Provide FBM-232 Field Device System Integrator (FDSI) module to enable “bridging” communication between Foxboro DCS to new Headworks and Transfer Pump Station facilities’ Allen Bradley / Rockwell Automation Controllogix PLC-based controls.

Upgrade all existing ICWRC Foxboro DCS software and HMI graphical systems to current Foxboro DCS architecture.

Integrate all new PLC-based equipment systems into the upgraded ICWRC Foxboro DCS system including deployment of a uniform and consistent graphical user interface design deployed on all local PLC Operator Interface Terminals (OIT) and Foxboro DCS Human-Machine-Interface (HMI) graphical workstations.

1-1.02. SRWRC DCS System Improvements. Hardware and software upgrades shall be implemented on the existing SRWRC Foxboro DCS system Fieldbus Modules (FBM’s) within enclosures remaining in service upon project completion based on lifecycle status (obsolescence and future availability) of Foxboro DCS hardware and software products. The existing UNIX-based workstations and servers will be replaced by new Windows Servers and workstations, while the old control processors and field bus modules will be replaced by their modern equivalent.

SRWRC DCS Upgrades/Modifications: Conduct a comprehensive (field verified) inventory of SRWRC DCS hardware, software, and I/O to provide complete and accurate record documentation reflective of the existing system installation. The inventory shall include verification of all existing software control block functions utilized for remote manual and automatic control of SRWRC plant treatment processes.

Implement all measures (temporary and permanent) required to maintain SRWRC operational integrity during decommission and demolishment process of project designated equipment systems monitored and/or controlled by SRWRC Foxboro DCS.

Implement all measures (temporary and permanent) required to identify and migrate existing process equipment systems monitored and/or controlled by SRWRC Foxboro DCS that will remain in service during and after construction of new facilities.

Implement all measures (temporary and permanent) required to maintain SRWRC operational integrity during DCS I/O migration of existing I/O systems from Foxboro ‘100 series’ I/O to ‘200 series’ I/O.

Admin Building Ground Floor. Replace (Foxboro DCS workstations with (current

Foxboro DCS hardware/software supported) Windows-based computers and operating systems. Re-use existing furniture.

Upgrade/replace two (2) workstations 1WP51A, 1WP51B to H92's.
Upgrade annunciator keyboards.

Admin Building – Upper Floor. Replace existing UNIX-based operator workstations and computer network components as listed below to current supported Windows-based release' of Foxboro DCS application software and supporting operator interface applications.

Install new G50 enclosure
Upgrade two (2) Ethernet switches from type 'A2' to type 'A4'
Upgrade / replace one (1) Workstation '1AW51A' to 'H90'.
Upgrade report writer, 1000 AIM*.
Combine and upgrade 1CP30C, and 1CP40A to FCP280
Upgrade 1ABGWA, 1ABGWB to FDSI.
Upgrade 1MODGA to FDSI.
Remove Nodebus interface, COMM10, ATS modules.
Upgrade 17 Reports – 9 Daily, and 8 Monthly Reports

Tunnel Pump Building. Replace existing UNIX-based operator workstations and computer network components as listed below to current supported Windows-based release' of Foxboro DCS application software and supporting operator interface applications. Reuse furniture.

Upgrade workstation TPAW01 (XP Tower) to H92 with ver. 9.x.
Provide new keyboard, mouse.
Upgrade two (2) Ethernet switches from type A2 to type A4.

Preliminary Treatment (1CP40A).
Upgrade twenty-two (22) 100 Series FBMs in enclosure DCM-2.
Upgrade ten (10) 100 Series FBMs in enclosure DCM-12.
Upgrade twenty-two (22) 100 Series FBMs in enclosure DCM-13.

Blower Building (1CP30B)
Upgrade five (5) 100 Series FBMs in enclosure DCM-9.
Upgrade workstation 1AW51B to H92.
Upgrade 500 point AIM*.
Upgrade annunciator keyboard.
Upgrade one (1) pair of CP30FTs (1CP30B) to FCP280.
Upgrade Integrator 30 1ABGWC with FDSI.

Filter Building (1CP30B)
Upgrade five (5) 100 Series FBMs in enclosure DCM-11.

Electrical Building (1CP30B)

Upgrade sixteen (16) 100 Series FBMs in enclosure DCM-3.

Primary Odor Control Building (ICP30C)

Upgrade twenty-three (23) 100 Series FBMs in enclosure DCM-14.

Dewatering Building (2CP30A)

Upgrade five (5) 100 Series FBMs in enclosure DCM-6D. (Upper Floor)
Upgrade five (5) 100 Series FBMs in enclosure DCM-6B. (Bottom Floor)
Upgrade five (5) 100 Series FBMs in enclosure DCM-6A. (Bottom Floor)
Upgrade two (2) Ethernet switches from type 'A2' to type 'A4' (Dewatering Control Room).
Upgrade 2WP51A, 2WP51B workstations to H92's.
Upgrade annunciator keyboards.
Upgrade and combine 2CP30A, 2CP30B into one (1) FCP280
Remove nodebus extender modules.
Remove FOXW02 module in Dewatering Control Room.

Secondary Odor Control Building (2CP30A)

Upgrade ten (10) 100 Series FBMs in enclosure DCM-64.

Digester Building (2CP30B)

Upgrade six (6) 100 Series FBMs in enclosure digester building

Recirculation Building (2CP30C)

Upgrade thirteen (13) 100 Series FBMs in enclosure DCM-4.
Upgrade Workstation 2AW51A to H92.
Upgrade 1000 point AIM*.
Upgrade one (1) CP30 (2CP30C) to FCP280.
Remove ATS modules
Upgrade two (2) Ethernet switches from type A2 to type A4.

TWAS Building (2CP30C)

Upgrade three (3) 100 Series FBMs in enclosure DCM-10

Integrate all new PLC-based equipment systems into the upgraded SRWRC Foxboro DCS system.

Upgrade all existing SRWRC Foxboro DCS software and HMI graphical systems to current Foxboro DCS architecture.

1-1.03. Control System. Section 17500 shall apply to all equipment furnished under this section. Additional software requirements are indicated in Section 17550.

1-2. GENERAL. Equipment furnished and installed under this section shall be

fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by ENGINEER.

1-2.01. General Equipment Requirements. The General Equipment Requirements section shall apply to all equipment provided under this section.

1-2.02. Drawings. Supplementing this section, the drawings indicate the number of Programmable Logic Controllers (PLCs), locations of PLCs, and provide diagrams and schematics regarding connection and interaction with other equipment. All DCS hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the drawings.

1-2.03. I/O List. The FBM-232 FDSI connected PLC input/output (I/O) field device signal listing is included as an appendix (17500-A) attached to section 17500. The DCS Supplier shall be responsible for incorporation of all PLC systems provided by Division 17500 System Supplier and incorporation of all PLC systems provided by packaged equipment systems to ICWRC and SRWRC DCS systems.

1-3. SUBMITTALS. Submittals for expansion of DCS incorporating replacement of Foxboro DCS I/O systems and communication to PLC systems shall be as required in Section 17500 and as noted below.

Provide preliminary loop drawings in general accordance with ISA S5.4. At the DCS end show FBM connections and as a minimum the I/O block definition. Make provisions to show all components and associated connections required including the following information:

1. Tag numbers of each item.
2. Functional name of each item.
3. Manufacturer's model or catalog number for each item.
4. Location of each item.

Prior to the Operational Field Testing, provide updated loop drawings with all information as required above.

Provide an updated field signal input/output (I/O) list with each point individually listed and cross-referenced to the loop drawings. Include updated versions of all information incorporating PC-based I/O lists referenced under Section 17500-A and remaining ICWRC Foxboro DCS I/O after demolishment of decommissioned facilities and decommissioned Foxboro DCS I/O.

Provide a legend and abbreviation list.

Provide updated DCS interconnection drawings showing all replaced DCS equipment, equipment locations, interconnecting cables and connectors with lengths indicated, and communication links.

Provide updated DCS enclosure layout drawings including the following information:

1. Front, side, and plan views.
2. Dimensions.
3. Nameplate legend including text, letter size, and colors to be used.
4. Terminal block designations cross referenced to the I/O list.

Provide a complete material and software list. Identify software components by title, functional description, revision identification and date, and other appropriate identifying information.

Provide the following product information for each component provided.

1. Manufacturer's product name and number.
2. Tag number (if applicable).
3. Functional name.
4. Description of construction and features.
5. Performance data.
6. Service requirements (power, environment, etc.).
7. Dimensions.

Drawings shall be prepared using latest version of AutoCad and shall be provided on hardcopy and CD-ROM media.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as required in Section 17500.
1-5. SPARE PARTS. Spare modules shall be supplied in the numbers as noted below:

Ten percent (10% - minimum quantity of two (2) each) shall be provided for each DCS hardware component. Hardware modules include (but are not limited to) the following:

Processors
Input / Output Modules
Power Supplies
Factory Pre-Fabricated Interconnect Cable Assemblies
Chassis Racks
Communications Processors

Twenty percent (20% - minimum quantity of ten) of each signal isolation and surge protection module.

Twenty-five percent (25% - minimum quantity of twenty of each type and size) of each fuse shall be provided.

PART 2 - PRODUCTS

2-1. SYSTEM REQUIREMENTS. The existing DCS shall be modified and expanded to provide the following functions as defined herein and in other sections:

- Data acquisition (monitoring and control) of stand-alone PLC-based systems.
- Alarm monitoring.
- Information display.
- System data reporting.
- Short- and long-term data storage.

The existing DCS shall be upgraded to the latest production version of Foxboro DCS as manufactured by Foxboro / Schneider meeting the system requirements herein and in associated sections, without exception.

Replacement of existing '100' Series Input/output (I/O) modules with '200' Series I/O modules shall be used for interfacing with sensors and receivers remaining in the plant after facility modifications.

Terminology in these specifications conforms to the definitions as given in applicable standards as specified in Section 17500. In addition, the following definitions shall apply:

Analog Point. Any analog input, analog output, or analog calculated variable.

Digital Point. Any digital input (low or high (SOE) resolution), digital output, or digital calculated variable.

Control Processor. An integral group of components used to execute control and data acquisition functions, consisting of power supplies, computer processors, memory, connection to the data highway communications network, and connection I/O communications network.

Operator Interface An integral group of components used to execute

Processor: operator interface functions, consisting of power supplies, computer processors, memory, and connection to the data highway communications network.

Operator Interface: An interaction between the Operator and the DCS Function wherein the Operator issues a command, and the DCS executes the command and provides the feedback information on the monitor or the printer.

Operator Work Station. A video monitor or set of monitors driven by a single Operator Interface Processor (server or client) and controlled by a single Operator interface device (keyboard, mouse, etc.) where the Operator interacts with the control system and the plant processes and performs the Operator Interface Functions.

Engineer/Operator: Similar to the Operator Work Station in composition

Work Station: except this station provides additional features for the Engineer/Programmer to perform programming and configuration functions.

Control Functions: Those functions involved with scanning, scaling, and linearizing process data, solving analog or Boolean control algorithms, and outputting commands to the plant processes and/or information to the Operator.

Modulating (Continuous). Analog control loops that produce an analog control output which continuously positions the final control element (control valve, damper drive, etc.) between the fully closed and the fully open positions, and the associated digital control logic for the control element interlocks, permissives, runbacks, etc.

Discrete (Sequential). Digital control logic that produces a digital Control output which operates the controlled equipment (motor, dampers, valves, etc.) in discrete steps (on, off, open, close, etc.).

Data Acquisition Functions. Those functions involved with scanning, scaling, and linearizing process data, calculating, and displaying plant measurement data used for information, not control, in the form of control and information displays and reports.

Sequence-of-Events (SOE). Those functions associated with scanning, time

Functions. tagging, and reporting the time of occurrence and sequence of digital input state change.

Foreign Device Interface. The hardware and software necessary to provide bidirectional communication between the DCS and third-party devices by means of a serial data interface protocol. This includes all necessary device drivers and application software to transfer Analog Points and Digital Points, including parameters such as value or status, point description, alarm state, and time tag.

Remote I/O. Input/output equipment, including I/O modules, racks, power supplies, interrogation power supplies, and connection to the remote I/O communications network, located in areas physically remote from the associated Control Processor. This I/O may be housed in SUPPLIER-furnished cabinets or in cabinets furnished by others.

Loop Oriented I/O. Cards containing analog inputs, analog outputs,

Cards. digital inputs, and digital outputs on a single card which are intended to be related to a single control loop.

Technician. Personnel that has knowledge and specific training to perform DCS hardware troubleshooting and maintenance, and to use the DCS system tools to troubleshoot plant equipment or control logic malfunctions. Technicians may also have knowledge and training to perform DCS system configuration at the Engineer/Operator Work Station.

Engineer/Programmer. Personnel that has knowledge and specific training to perform DCS system configuration at the Engineer/Operator Work Station, and to use the DCS system tools to troubleshoot plant equipment or control logic malfunctions.

User. Technicians and/or Engineers/Programmers that perform DCS system configuration at the Engineer/Operator Work Station.

Operator. Personnel that have knowledge and specific training to operate the plant and its equipment by using the features of the Operator Work Station.

2-1.01. System Acceptability. The upgraded system shall be designed and equipped to withstand to the maximum extent possible, lightning surge by atmospheric electrical disturbance without damage or disruption. The system architecture shall accept new technology as it becomes available, and future system enhancements shall be compatible with the equipment supplied under this Contract so that extensive hardware and software retrofitting is not necessary. SUPPLIER shall not propose nor provide equipment from any manufacturer that is expected to be superseded or outdated by a later generation of equipment prior to the final acceptance date. All equipment shall be new, unused, and of the highest quality available from the manufacturer.

2-1.02. System Integrity. The DCS design shall continue to incorporate functional and component redundancy to ensure maximum reliability during system operation, so that no single component failure, with exception of individual I/O modules, shall affect the Control and Data Acquisition Functions of the system.

Redundant controllers, transmitters, receivers, internal wiring and data busses, and cabling shall be provided on all expansions of the existing data highway

communications networks directly related to Control and Data Acquisition Functions unless specifically noted in the plans or specifications. This includes the I/O communications networks from I/O to Control Processor and Control Processor to Control Processor data highway communications networks.

All replacement / upgraded processors performing Control and/or Data Acquisition Functions (unless specifically noted in the plans or specifications) shall consist of a redundant pair of Control Processors. One member of the Control Processor pair shall be active; the other member of the pair shall be operating in a continuously updated, hot standby mode.

Internal power supplies shall be provided by SUPPLIER in a configuration so that the loss of one power supply shall not affect any control functions in the DCS.

The system shall be designed so that a failure of any Operator Interface Processor shall not cause the loss of automatic process control functions or affect the operation of other workstations.

2-1.03. Failure Modes. SUPPLIER's design shall carefully consider the effects of potential hardware and software failures on the functions being performed by the system. The system shall be designed to:

Detect failures by use of continuously running diagnostic routines and bring them to the Operator's attention.

Provide hardware and software designs that react to failures in a predicable and repeatable manner.

Mitigate the effects of failures by use of equipment redundancy, software error correction, or other available means.

General cases of failure modes and the required system response are as follows:

System Power Loss. System control outputs shall fail to a predefined safe status. Control Processors shall automatically restart upon restoration of power.

Control Processor Failure. Control shall transfer to the backup Control Processor in a bumpless manner. If the backup Control Processor is not available, the outputs shall fail to a predefined status. Output failure status shall be User selectable for fail-in-place, fail high, fail low, fail on, or fail off.

Control Processor to Data Highway Communications Network Failure. Failure of a single communication channel shall result in the bumpless transfer of communication to the redundant channel. In the case of failure of all communication, the Control Processor shall continue to operate and control its

outputs, and information received over the data highway communications network shall be treated as signals with bad quality.

I/O Subsystem Failure. Associated output points shall fail to a predefined safe status. Under failure conditions, inputs shall be treated as signals with bad quality within the Processor.

I/O Subsystem to Control Processor Data Highway Communications Network Failure. Associated output points shall fail to a predefined and repeatable safe status. Output failure status shall be User selectable. Under failure conditions, inputs shall be treated as signals with bad quality within the Control Processor.

Foreign Device Interface Processor or FDI Communications Network Failure. Signals being received from the foreign device shall fail to a predefined status. Failure status shall be User selectable. Under failure conditions inputs shall be treated as signals with bad quality within the FDI Processor.

2-1.04. System Timing. The update rate, processing rate, and response time of all Control Processors and the data highway communications network, and of the overall system shall sufficiently maintain control over the plant processes and equipment under all system operating conditions including extreme upset conditions with all points in alarm.

At a minimum, the system shall scan all inputs and outputs, process all control logic, and perform all other functions required to record the changes and the time of the changes as follows:

The scan rate for all I/O shall be User selectable.

Analog inputs and analog outputs shall be scanned at least every 0.5 second with at least 10 percent of the inputs and outputs scannable at a 0.1 second interval.

Digital inputs and digital outputs shall be scanned at least every 1.0 second.

Digital SOE inputs shall be scanned at least every 0.001 second. The time resolution of these points in different Control Processors shall be the same as SOE points residing in the same Control Processor.

All non-SOE alarms shall be time tagged to a resolution of 1.0 second.

The processing rate for all control logic routines and calculations shall be individually selectable.

Modulating Control logic and calculations shall be processed at least every 0.5 second with the capability to process at least 10 percent of the logic at a 0.1 second interval.

Discrete Control logic shall be processed at least every 1.0 second.

At a minimum, the system shall respond to Operator commands and control system changes as follows:

Time to completely generate a display shall not exceed 2 seconds.

The indication of any variable, on all displays including alarm displays, shall be updated within 1 second of its value or status change.

The time to respond to any Operator command shall not exceed 2 seconds.

The time to respond for Foreign Device Interface functions shall not exceed 2 seconds (response time will not include the time required for the foreign device to respond to the DCS; only the actual bidirectional communication time shall be considered).

The response time is the total elapsed time for transmission of data through the system communications path. This time shall include all communication time from Control Processor to Control Processor, I/O scans, nodes, Foreign Device Interfaces, monitors, keyboards, and associated equipment internal to the system.

2-1.05. System Capacity. SUPPLIER shall provide additional configuration capacity (based on existing system configuration) for all I/O points listed under Appendix 17500-A plus fifty percent (50%) software expansion capacity. The spare capacity shall be computed complete engineering and implementation of all specified functions. The installed and licensed spare capacity will be used to accommodate any Control and Data Acquisition Functions that may be added to the system during the startup phase of the project and thereafter. All spare I/O shall be configured spares as far as the database of each control processor is concerned.

Any additional spare DCS I/O (excluding PLC-based I/O listed under 17532 and Appendix 17500A) shall include all required I/O modules, power supplies, cabling, and terminal blocks. Spare I/O points and spare terminal blocks shall be spaced evenly throughout each cabinet.

Any additional spare DCS card slots shall be fully equipped with hardware and wiring at the time of shipment so that all that is required to activate and use the slot is the addition of a new module. The system shall include all backplane wiring, card to terminal block wiring, and power supply wiring necessary to support the spare capacity. Where terminal blocks or terminal cards are unique to the type of I/O module to be

installed, the cabinet design shall be such that the new I/O module to termination device wiring and the termination device can be easily installed by the User.

For components of the system that have modular power supplies, SUPPLIER shall provide the spare space/slots required. For components of the system that have non-modular power supplies, SUPPLIER shall include sufficient power supply capacity for OWNER to fully utilize the available spare slots without the addition of power supply modules.

2-1.06. Service Conditions. All equipment shall be designed for operation in plant areas with the environments defined in applicable sections.

2-2. PROCESSING FUNCTIONS.

2-2.01. Input/Output Processing. During each scan cycle, the system shall perform the following input processing functions:

Apply time tag (at remote equipment for all Remote I/O, at I/O card for all digital SOE inputs).

Software filters shall be provided in addition to the hardware filters for certain analog inputs as determined during detailed design.

Open circuit detection (thermocouple inputs).

Sensor limit (signal out-of-range)/field signal loss check (including quality classification as good, questionable, or bad, or some other similar set of designators).

Thermocouple reference junction temperature compensation shall be provided.

All analog outputs shall be monitored by continuous system diagnostics. (An open loop in any analog output shall result in a control action to be defined during detailed design.)

The system shall provide the following additional processing capabilities for all I/O:

- Provision to manually substitute (force) values.
- Provision for each I/O to be removed from and returned to scan.

The actual points requiring manual substitution and scan control shall be as determined during detailed design.

2-2.02. Input Calculation Processing. The system shall convert analog inputs into engineering units. This conversion shall be software based so that each point can have

its own range. Conversion types shall include linear, thermocouple, RTD, flow compensation, polynomial approximation for special input conversion, logarithmic conversions, and all other types required for the application. Standard conversions shall be provided for all specified thermocouple and RTD types of both degrees F and degrees C. Each conversion type shall handle different ranges for the variable. High level programs shall be used for special conversion types.

The system shall perform real-time calculations using all of the input data processed. Calculation routines shall include, as a minimum, the following:

- Arithmetic, exponential, and trigonometric functions.
- Time-based functions (integration, rate-of-change, moving average, and similar functions).
- Boolean calculations.

The system shall further perform real-time calculations using the calculated variables.

Point quality shall be carried through all control algorithms and calculations where required for control and Operator indication, and the data value shall be displayed as asterisks or with a quality tag if the quality is other than “good.”

Digital inputs will have one or more of the following functional uses:

- Alarms
- Logic functions
- Control functions

Digital SOE inputs shall have the same functional uses and shall also be used to determine the cause of trip of major items of plant equipment.

2-2.03. Modulating (Continuous) Control Functions. SUPPLIER shall engineer and configure a complete set of programmed instructions in the new PLC-based controls to execute the Modulating Control functions specified in applicable sections (excepting PLC-based systems provided by packaged equipment suppliers).

The written descriptions and/or functional logic diagrams provided in Section 17550 describe only the main logic strategies to be implemented in the new PLC-based controllers. The “housekeeping” functions such as rejection to manual, signal tracking, bumpless transfer, generation of alarms, internal and external displays, and the like, are not described. The logic developed and configured by SUPPLIER shall include tracking, indexing, reset anti-windup, bumpless transfer, and all other functions required to prevent control system and process upsets when any system mode is changed automatically or by the Operator. SUPPLIER configuration shall include directional blocking of control outputs to prevent exceeding limits on critical operating variables where required by code compliance and good operating practice.

The written descriptions and/or functional logic diagrams provided in plans and specifications describe the minimum criteria for the control system. However, it is not intended to limit the operation, function, and safeguards to those mentioned or implied. SUPPLIER shall make any additional suggestions or recommendations that will improve the proposed operational procedures or method of control. All configuration effort required for a fully integrated, complete, and operable control system shall be supplied whether specifically detailed or not.

All Modulating Control loops to be executed within the new PLC-based controllers shall have automatic and manual capabilities as required by system design and as detailed under 17550. Protective interlock actions (priority increase, priority decrease, hold) shall be enforced by the system logic regardless of whether the control loops involved are in automatic or manual control. The control system shall enforce a predetermined order of initiating automatic control of related functions. If a lower level loop is commanded to manual control, the related upper loops shall automatically reject to manual control. System capability shall allow Analog Point quality as determined during input processing to be used to reject associated loops to manual control as determined during detailed design. A control loop which has been rejected to manual control shall not revert to automatic control without Operator initiation.

In cases where the DCS modulates more than one similar auxiliary device (e.g., High Service Pumps, filters, chlorine feeders, etc.), the logic shall automatically compensate the tuning constants of all affected control loops so as to provide equally responsive control no matter which combination of auxiliary devices may be in service and on automatic. The DCS shall permit automatic operation of some similar auxiliary devices even though some of such devices which may be in service are being operated manually. The control system shall include function generator compensation to outputs so as to linearize control response when modulating final devices which may not be linear, as required by system design.

Multiple input signals will be provided for the certain variables including, but not necessarily limited to, transfer pump station wet wells and other process descriptions listed in applicable sections. The control system shall provide logic to allow the Operator to select the multiple measurement mode. The modes shall include selection of any one of the measurement signals, the average or the median of the signals. The logic shall also automatically allow selection of only those inputs that are not in "bad" quality. Comparison logic shall be provided to determine and alarm significant deviation of the signals. If determined during detailed design, such a deviation shall reject all control loops associated with this signal to manual. Means shall also be provided to enable resumption of automatic control in the event of such a rejection at the Operator's discretion.

The control system shall provide logic to accumulate pulses and shall allow manual and automatic hold and reset of the pulse accumulation. The logic shall also convert the accumulated pulses to engineering units.

The logical connections between functional blocks within all logics shall be represented in engineering units. It shall not be acceptable to present these values as a 0 to 100 percent signal, which requires that the User manually convert the values to engineering units to troubleshoot equipment or configuration problems.

2-2.03.01. Operator Interface Functions. Operator Interface Functions shall include interface to analog control loops, multiple measurement loops, and pulse accumulator loops, by the Operator from faceplates on the Operator Work Station monitors.

The analog control loop control stations shall simulate conventional hand/auto stations, allowing the Operator to select mode and to provide manual interface commands, and shall provide a display of all relevant variables associated with the control loops including the set point, the feedback signal, the control signals, and the status of the loop.

The required modes of operation and Operator controllable parameters shall be as follows:

Automatic Mode. This mode shall permit fully automatic operation of the system with no intervention on the part of the Operator except for the functions designated as Operator adjustable, such as set point adjustment and biasing of control signals.

Manual Mode. This mode shall permit manual "Raise" and "Lower" of system demand signals.

Operator interface for analog control loops shall also include one, two, three, and four vertical bar indicating stations for indication of analog values. Each vertical bar on the station shall also display a short description of that point, and the point's process value and engineering units.

The multiple measurement loop control stations shall allow the Operator to select the multiple measurement mode and shall provide a vertical bar and analog value display for each of the analog inputs and for the multiple measurement loop output. The station shall also display the multiple measurement mode and quality of each analog value.

The pulse accumulator loop control stations shall allow the Operator to reset and hold pulse accumulation and shall provide an analog value display of the accumulated total.

All Operator interface command functions, except screen paging, shall be designed for two-step operation. The Operator shall be required to make one keyboard or pointing

device action to select the function to be performed and a second keyboard or pointing device action to execute the function. For example, the Operator must select the "Auto" button for a device and must then select to execute the auto function to prevent accidental pointing device or keyboard activation of control commands.

The system shall provide system displays for on-line monitoring of control logic signal flow on any Operator Work Station in the system. These displays shall use color and other unique symbology or nomenclature to indicate input and output values, block parameters, and signal flow path for all function blocks and associated connections.

2-2.03.02. General System Performance. During transient conditions causing deviations of process variables, the control system shall not permit deviations that exceed those required to safely operate the plant. The DCS shall be capable of producing smooth load changes without overshoot, based on the general guidelines indicated in Section 17500, unless these changes are not achievable because of plant equipment limitations. In no event shall the performance of the control system become the limiting factor on plant responsiveness. The process and mechanical end elements should be the limiting elements in the control of the process.

2-2.04. Discrete (Sequential) Control Functions.

2-2.04.01. Motor Control Functions. As required by applicable sections, SUPPLIER shall engineer and configure a complete set of programmed instructions in the new PLC-based controllers to execute the motor control functions, which shall include, but not necessarily be limited to, the following:

- Start/Stop of motors for pumps and equipment.
- Open/Close/Stop of motor-operated valves and equipment.
- Open/Close of solenoid-operated valves and equipment.

2-2.04.02. Operator Interface Functions. Operator Interface Functions shall include mode selection and initiation of manual commands, made by the Operator from control stations on the Operator Work Station monitors. The control stations shall provide control functions, including, but not necessarily limited to, the following:

- Start, stop, open, close, auto, manual, reset, and trip commands.
- Maintained push buttons.
- Momentary push buttons (with adjustable pulse duration).
- Status indication for motor running/stopped/tripped and valve open/closed.
- Indication for equipment mode, permissive condition, failure condition, first-out indication, and operational sequence status.

All Operator Interface Functions, except screen paging functions, shall be designed for two-step operation. The Operator shall be required to make one keyboard or pointing

device action to select the function to be performed and a second keyboard or pointing device action to execute the function. For example, the Operator must select the "Start" button for a device and must then select to execute the start function to prevent accidental pointing device or keyboard activation of control commands.

The system shall provide system displays for the on-line monitoring of control logic signal flow on any Operator Work Station in the system. These displays shall use color and other unique symbology or nomenclature to indicate on-state, off-state, and signal flow path for all logic blocks, contacts, coils, and associated connections in accordance with Section 17500.

2-2.04.03. Device Tag-out Function. The system shall allow the Operator to place any plant motor or solenoid operated device in a "tag-out" condition from a control station for that device. The tag-out function shall simulate placing a "Do Not Operate" tag on a physical control station but will not replace the requirement for electrical and/or mechanical disabling of the equipment prior to maintenance.

The Operator will be required to place the device's mode and output in the desired state prior to initiation of the tag-out function. The system shall then prevent the changing of the output or the mode of the associated logic either by the Operator or by the control logic while in the tag-out state. Tag-out status shall be stored in nonvolatile memory, so that the tag-out state is retained on Control Processor failure and subsequent restart.

SUPPLIER shall provide device tag-out logic and Operator interface configuration for all power operated valves, motors, and electrical supply breakers included in the scope of SUPPLIER's programming services.

2-2.05. Alarm Functions.

2-2.05.01. Analog Alarm Functions. The system shall perform comparison of limits functions on any or all Analog Points, as determined during detailed design. The system shall allow the User to selectively activate or deactivate these alarms. Each analog input variable, or calculation result, shall have an individual set of alarm limits. These limits shall be either manually set, calculated as functions of other variables, or rates of change with time. Violations of these limits shall initiate alarms and/or initiate execution of special software programs. The analog alarm functions shall be on a per Analog Point basis, and shall include, but not be limited to, the following:

- Provision to assign high and low transducer range limits for quality determination.
- Provision for Analog Points to be deleted from and restored to alarm status by the User or automatically from internally generated variables.
- Provision to assign high and low alarm limits, and at least one level of incremental alarm limits, either fixed or as a function of another system point.

- Provision to assign an alarm deadband.
- Provision to assign rate of change alarm limits and deadband.
- Provision to impose alarm cutout conditions as a function of another system point.

2-2.05.02. Digital Alarm Functions. The system shall compare the status of any or all Digital Points (Digital inputs and/or SOE Digital inputs) against the User selectable alarm state of these points, as determined during detailed design. The system shall allow the User to selectively activate or deactivate these alarms. Digital Points entering the alarm state shall initiate alarms and/or initiate execution of special software programs. The digital alarm functions shall be on a per Digital Point basis, and shall include, but not be limited to, the following:

- Provision for Digital Points to be deleted from and restored to alarm status by the User or automatically from internally generated variables.
- Provision to alarm on a Digital Point status of "1" (on) or "0" (off).
- Provision to alarm Digital Points on any change of status.
- Provision to impose alarm cutout conditions as a function of another system point.

2-2.05.03. System Alarms. The system shall provide alarms for system failure conditions including, but not limited to, the following:

- Loss of any redundant power feed.
- Cabinet temperature high or loss of power to cabinet cooling fans (for all electronics cabinets).
- Power distribution breaker trips and/or blown fuses.
- Loss of any voltage level from any power supply.
- Battery low (many hours before deterioration to the extent that it cannot maintain the functions of the equipment it supplies).
- Failure of any Control Processor.
- Failure of any Operator Interface Processor.
- Failure of any system input or output module.
- Failure of any Foreign Device Interface.
- Failure of any communications controller.
- Diagnostic programs shall have routines to generate component status alarms.

These alarms shall include, but not be limited to, the following:

Control and Operator Interface Processor failure.
Communications failure.
Disk read/write error.
Printer failure.

All failure alarms shall identify the failure at least to the cabinet level and preferably to the module or card level. All failures and malfunctions, when detected, shall immediately be alarmed through the Operator Work Stations and recorded on the alarm printer(s).

2-2.05.04. Alarm Annunciation. The system shall allow any Operator Work Station to be designated the alarm work station, and this designation shall be Operator selectable. All alarms shall be displayed on the alarm work station monitor. The system shall also include an audible alarm that shall have adjustable volume control. The audible alarm shall be User configurable for different tones or patterns to distinguish between a minimum of four alarm priority levels. The system shall use global alarm acknowledgment, allowing a single acknowledgment from any work station, whether designated as the alarm work station or not, to acknowledge that alarm on all work stations and to silence the audible alarm.

The system shall record all alarm events to a disk file in chronological order.

A printer shall be designated as the alarm printer which shall automatically print out each alarm event and alarm reset as it occurs. The alarm printer designation shall be User selectable. In the event the DCS detects the printer selected as alarm printer is unavailable, the DCS shall transfer the alarm printing functions to a utility printer; or if no printer is available, the DCS shall retain the alarms in buffer memory for printout on the first available printer.

2-2.06. Calculations.

2-2.06.01. Real-Time Variable Calculations. The system shall perform real-time variable calculations within the new PLC-based controllers using input data and other calculated variables. SUPPLIER shall be responsible for performing all calculations required to meet the control and information functions specified herein.

Calculated variables are defined as system database points that are derived from software calculations of a level higher than the initial input point conversion to engineering values. These calculated variables shall be available for use in other calculations, control logic, control and information displays, reports, trending, historical data storage, and Foreign Device Interfaces.

These calculations shall include all functions commonly used in boiler-turbine control systems and all other functions specified herein. SUPPLIER shall supply all standard formulations such as pressure compensation, temperature compensation, specific volume, etc. All calculation results shall be automatically quality coded according to the worst quality of any of the inputs to each calculation.

2-2.06.02. Performance Calculations. Performance calculations shall be configured for all equipment utilizing power monitors or involved with delivery and feed of process chemicals and process water.

These calculations shall be performed automatically, generally for purpose of detecting and alarming plant malfunctions and determining the performance of individual items of equipment. The calculation interval shall be User selectable. Not all calculations shall require the same interval.

These calculations shall be performed using averaged data which is accumulated over time. The time shall be User selectable from 0 to 10 minutes. If measured data is not actually available in the process, manually inserted values shall be used. The system shall include provisions for substitution of values in the data set. The User shall be able to input flow and chemical consumption data and other manually inserted data into the system for the calculations.

SUPPLIER shall be responsible for configuring performance programs to comply with this specification and to conform to the actual treatment and delivery processes.

SUPPLIER shall provide all displays and reports required to show the results of the performance calculations, including trend displays of pertinent data and controllable losses screens if applicable.

2-2.07. Control and Information Display Functions. The display functions as described herein shall be assignable by the Operator to any DCS work station within the system.

All system points including analog, digital, and calculated variables shall be capable of being displayed on the Operator Work Station monitors. The use of color on the displays shall serve to rapidly draw Operator attention to important data. The color of each item shall be in accordance with Configuration Standards and Conventions per Section 17500. Time and date shall be displayed on each display.

2-2.07.01. Trend Displays. Trend displays shall simulate a multiple pen strip chart recorder and shall consist of a time plot of a minimum of four points concurrently. Each trace shall be in a unique color. Alphanumeric information shall be overlayed on the same screen to identify points, scales, current value, and related information. Chart rolldown shall be included. Chart roll shall be in the horizontal direction with the latest value appearing at the right-hand side of the screen. Time shall be plotted on the horizontal axis. The Operator shall be able to set the zero and full-scale values for each trended variable in any screen location. The system shall permit the Operator to set the grid roll speed and the interval between time lines. The system shall provide standard trend displays with variable full-scale time ordinates. All trends shall be backward and forward scrollable from the trend start time. Selection of points to be trended shall be menu driven.

The system shall allow any system variable to be trended, and shall allow points from short-term and long-term storage to be trended. The trend display period between points on trends using data from short-term and long-term data storage shall be the same as the storage frequency selected for those points. Trending resolution shall not be coarser than ±1/2 percent full scale using pixel displays.

The system shall also provide the capability to incorporate trend displays into any User created control or information display.

The system shall be sized to allow simultaneous designation of the quantity of trend displays specified in Section 17500. Trend displays will be defined by the OWNER and shall be configured at the factory by SUPPLIER as required.

2-2.07.02. Bar Chart Displays. Upon request, the system shall display dynamic bar charts. The bar chart format shall consist of a series of separate display pages, each with a minimum of 20 vertical or horizontal bars. Each bar shall represent the value of a measurement. Alphanumeric information shall be overlayed on the same screen to identify points, scales, current value, and related information. Each point shall have high and low alarm limits values which shall be shown. Any bar in the group which traverses beyond its limits shall be identified by a change in color.

2-2.07.03. X-Y Plot Displays. Upon request, the system shall graphically display the relationship between two Analog Points on X-Y plots. This display shall permit up to four points on the Y-axis to be plotted against a single point on the X-axis.

The system shall have the capability to store curves (value of Y expressed as a function of X such as a pump curve) and impose the curves on the X-Y plots as static displays.

Alphanumeric information shall be overlayed on the same screen to identify points, scales, current values, and related information.

2-2.07.04. Process Control Displays. The DCS shall be modified to include new process control displays designed to provide the means for the operator to monitor and control the plant equipment. Each process control display shall contain textual, geometric graphic, dynamic analog trending, dynamic bar chart, and alarm information representing plant systems, equipment, and other process information.

The new and modified existing process control displays shall be implemented on a high-resolution display system that, at a minimum includes the following capabilities:

Each display shall allow selection of at least 256 colors from a color palette of at least 65536 colors.

Alphanumeric characters shall be displayable in different sizes.

Dynamic numeric data linked to analog variables shall display the current numeric value of the variable, scaled as specified in the database, with engineering units.

The latest in pictorial abilities such as automation of symbols with three-dimensional effects applied to lines and symbols shall be available.

Standard geometric shapes shall include, as a minimum, lines, polygons, rectangles, arcs, ellipses.

Standard geometric symbols (tanks, vessels, pipe, valves, etc.), and the ability to create new symbols using standard symbols and standard geometric shapes shall be included.

The capability to fill any closed geometric shape with any available color shall be included. This capability shall allow fill in proportion to the value of an analog variable, and to select the fill color in response to the analog variable or according to the status of a discrete variable.

The display system shall also include the following User selectable capabilities:

- Creation, modification and selection of colors in the color library.
- Definition of attributes of all textual and geometric graphic elements, such as color, line weight, line type, blinking, and dynamic conditional linkage to system variables and attributes.

The system shall provide at a minimum, the capability for any process control display to show 200 dynamic variables (analog and digital) and/or geometric symbols, control 10 data entry points, and control 100 target points. Based on an Operator clicking on or selecting a dynamic variable, the system shall provide the functionality to jump directly to its point detail display. Through Operator entry of a value into a data entry point, the system shall provide the functionality to store and use that value for process and equipment control, for example, sending operation limits of the plant or other manually entered data to the dispatch system via database points. By an Operator clicking on or selecting a target point the system shall, at a minimum provide the following functionality:

- Activation of a "pop-up" control station as defined below, to allow process and equipment control.
- Activation of a display and/or trend.

The system shall be sized to store and display the quantity of process control displays as required per Section 17500 and other applicable sections. Process control displays will be defined by the OWNER and shall be factory configured by SUPPLIER in the quantity specified in Section 17500. For bidding purposes, SUPPLIER shall assume that each process control display will include 100 dynamic variables (analog or digital) and/or geometric symbols and control 50 target points.

2-2.07.04.01. Pop-up Control Stations. The system shall include pop-up control stations which the Operator can call-up to operate the plant equipment. Each control station shall "pop-up" on the current process control display when selected by the Operator. The system shall not allow simultaneous display of more than one pop-up control station on any process control display. The pop-up control stations shall provide the Operator Interface Functions specified in Sections 2-2.03.01 and 2-2.04.02.

The system shall include a library of predefined pop-up control station templates that shall be used to create control stations for Operator control of plant equipment. Templates provided shall include auto/manual analog control stations, bias stations, hand stations, ratio stations, motor control stations, valve/damper control stations, burner control stations, equipment tag-out stations, pulse accumulator control stations, and multiple measurement control stations. The system shall allow the User to add to or modify templates in the library as well as to create a unique User library.

Each control station template shall be available as many times as needed by defining the text and database point information specific to a particular piece of plant equipment. The system shall allow a control station for any plant device to be selectable from as many process control displays as required for proper plant operation.

2-2.07.05. Faceplate Displays. Faceplate displays shall be defined as a fixed grouping of pop-up comparable control stations designed to provide a set of related Operator control functions. SUPPLIER shall configure faceplate displays as required per Section 17500 and other applicable sections. SUPPLIER shall define the grouping of control stations for each faceplate display as required to provide for safe and efficient operation of plant equipment. Control station groupings shall be submitted to the OWNER for review prior to faceplate display configuration.

2-2.07.06. Text Displays. The DCS shall include text displays to provide information to aid in the operation of the plant and its equipment. Text displays shall include equipment permissive displays, help displays, equipment run time displays, and sequence displays.
Equipment permissive displays shall be provided to dynamically indicate the conditions which must be met for a designated piece of equipment to start or operate. Color differentiation shall be used to inform the Operator of the current status (allow or disallow operation) of each condition. Access to an equipment permissive display shall be by a single Operator command once the equipment has been selected.

Help displays shall be static text displays that provide guidance messages on the operation of the DCS or plant equipment. Access to a help display shall be by a single Operator request once the operation or equipment has been selected.

Equipment run time displays shall be provided to dynamically indicate the accumulated running time in hours for selected plant equipment. The displays shall include the ability for the Operator to individually reset the counter for each device.

Sequence displays shall provide dynamic indication of the status and progress of equipment, group, and unit level startup and shutdown sequences. The displays shall include static text for each step of the startup, dynamic text to indicate process values or statuses, and links to other displays for individual equipment startup. The sequence displays shall include, for each step, an individual indication that confirms that each step has been completed. Sequence displays shall provide the Operator with the ability to start, stop, step, hold, and set the mode of each sequence.

The system shall be sized to store and display the quantity of text displays as required per Section 17500. Text displays will be defined and shall be configured at the factory by SUPPLIER as required per Section 17500. The quantity of each type of text display will be selected by the OWNER.

2-2.07.07. Group Displays. The system shall allow the User to create and store text type displays which show the tag name and point description adjacent to the current value or status of selected groups of points. The User shall be able to create each display from a SUPPLIER programmed template which allows the User to enter the point tag name for at least 50 points in a columnar format. The system shall provide storage for 50 such groups for display by the Operator.

2-2.07.08. Alarm Displays. The text type alarm displays shall display all points (analog or digital) in the alarm state in the form of written messages with each message containing tag name, point description, time tag, point value or status, and alarm limit.

The alarms shall be displayed on the monitor in the order of occurrence. An alarm, when first output to the screen, shall be displayed on the top line of the screen. A newer alarm shall push all older alarm messages on the screen down by one line. All alarm messages pushed out of the screen shall be backlogged and organized in pages.

The system shall be capable of displaying the backlogged alarm pages on demand by the Operator. When an alarm point has been returned to normal, the message shall disappear from the display after it is acknowledged. The system shall categorize all points in alarm into priority levels, and distinctions shall be made between high priority level and low priority level alarms when displayed on the monitors and printers.

The system shall allow the Operator to filter the alarm display on any Operator Work Station by priority or specific plant area (if the User has assigned plant areas). The filter shall be applied to the alarm display on that particular Operator Work Station only.

A separate alarm history display shall be provided which displays the most recent 5,000 alarm occurrences in chronological order. The alarm history display shall display alarms of all priorities, incremental alarms, and return to normal messages.

2-2.07.09. System Displays. SUPPLIER shall provide a hierarchy of system displays that provide status and health information for the system and for all individual components (cards, modules) within the system. These system status displays shall provide the User with a detailed view of the system as designed to indicate the status of each component along with an associated diagnostic summary for each component. Equipment status indication shall be distinctive as to allow determination of health, trouble, or fault for each Operator Interface Processor, Control Processor, power supply, I/O module, and associated memory or special function module used in the system. These system displays shall be in addition to the quantities of displays listed required to comply with requirements of Section 17500.

2-2.07.10. Summaries. The system shall be configured to allow the Operator to display on any Operator Work Station monitor and print the following summaries:

- Summary of all points in alarm.
- Summary of all existing "bad" quality points.
- Summary of all existing points with substituted (forced) values.
- Summary of all existing points not being scanned or alarm limit checked.
- Summary of all existing analog and digital inputs and outputs with point specifications such as ranges, limits, etc.
- Summary of all points in tag out.

2-2.08. System Data Reporting Functions. The DCS shall provide data reporting functions as defined herein. All reports shall be made from stored data so that once a report is initiated it can be completed without interruption. The system shall include major types of reports described below.

The system shall include a library of SUPPLIER-configured report formats as specified in Section 17500. SUPPLIER-configured reports shall include all required headers, footers, subheadings, column headings, and descriptive text.

The system tools shall allow the User to assign run-time properties to any report format, such as specific point tagnames, title, filename, execution time or event information, and destination. For each report the User shall be able to define whether that report is sent to a printer, viewed on screen, or saved as a file with complete formatting information. Supported file types shall include, as a minimum, comma-delimited ASCII, Microsoft Excel spreadsheet, and HTML.

2-2.08.01. Periodic Reports. Periodic reports shall contain the current and averaged values of system variables collected during the period. The reports shall be printed out

automatically at designated times, and on demand by the Operator. Each report shall be designed to collect data for a minimum of 100 points. The actual number of points contained in each report, the points to be collected, and the print times shall be User selectable.

2-2.08.02. Trend Reports. Trend reports shall contain current and averaged values of system variables at predetermined intervals. The reports shall be printed out automatically at designated times, on demand by the Operator, and automatically on the occurrence of a designated event. Each report shall be designed to collect data for a minimum of 100 points. The actual number of points contained in each report, the points to be collected, the print times, the length of the collection intervals, and the designated event shall be User selectable.

2-2.08.03. Maintenance Data Report. The maintenance data report shall calculate and display the number of starts and stops and the accumulated running time of all rotating equipment monitored by the system. The report shall be printed out automatically at designated times and on demand by the Operator. The report shall be designed to collect data for a minimum of 100 pieces of equipment. The actual quantity of equipment contained in the report and the print times shall be User selectable.

2-2.08.04. Housekeeping Report. The housekeeping report shall contain a listing of all changes made to the system by operating and engineering personnel. The reports shall be printed out automatically at designated times and on demand by the Operator. The print times shall be User selectable.

2-2.08.05. Sequence-of-Events Report. The Sequence-Of-Events (SOE) report shall contain the status changes of all SOE points, from all Control Processors, after a status change of a trigger point. The system shall allow any or all SOE points to be a trigger point, and this designation shall be User selectable. The report shall be printed out after a designated time delay. The designated time delay shall be User selectable. The system shall store the reports of the five most recent events, in chronological order, for later retrieval on demand by the User.

2-2.08.06. User Reports. The system shall also include a report writer Package that allows the User to create, edit, and store new reports and new report formats in addition to SUPPLIER-configured reports defined above. The reporting package shall allow reports to be built in a flexible free-format environment similar to commercial spreadsheet software and shall provide the following features:

- Real-time data, historical data, and messages combined in flexible layouts to produce meaningful reports.
- Information such as headers, footers, number of columns, column format, column headings, calculation equations, and descriptive text defined and entered by User for each report.
- Reports enhanced through use of various formatting styles, color to

highlight information, and insertion of charts such as bar charts and pie charts.
- User created templates and macros for frequently used formats.

The system shall provide storage for the quantity of User reports defined in Section 17500.

2-2.09. Historical Data Functions. The DCS shall provide historical data functions as specified herein. The data collection and storage system shall provide the following features:

- Collection frequency, point collection delta value, or collection change of state shall be User selectable on a per point basis. At a minimum, collection frequencies of 1 second, 10 seconds, 1 minute, 10 minutes, and 1 hour shall be provided.
- Point data to be stored, at minimum, shall consist of tagname, value or status, and time tag.

The upgraded historical application server(s) shall provide simultaneous collection of historical data from all new PLC-based controllers, existing (remaining after demolition and upgrade) PCU unit I/O and internal calculated (virtual) points.

2-2.09.01. Short-Term (Trend) Data Storage. As required by 17500, SUPPLIER system shall provide short-term data storage to allow data retrieval for recent and active trend displays. Any system variable (I/O point, calculated variable, etc.) shall be available for storage. This stored data shall be available for display in any trend display, any process control display, or any report.

The system hardware and software shall be sized to allow collection and short-term storage as defined in Section 17500.

2-2.09.02. Long-Term (Historian) Data Storage. As required in Section 17500, SUPPLIER shall provide a complete (hardware and software) long-term data storage system to store plant data and information on permanent storage media for later retrieval and use. The historian shall provide storage of plant information in a format that is accessible to all DCS applications as well as external databases and third-party applications.

The historical database shall support data access through standard ODBC (Open Database Connectivity) and SQL (Structured Query Language) queries. The retrieved data shall be available to any of the normal system peripheral devices such as Operator Work Station monitors and printers. The long-term data shall be available for use in trend displays, process control displays, reports, and calculations.

The historical database shall support native connections to Crystal Reports for user

customized SQL queries and reporting. SUPPLIER shall provide any additional software required to support Crystal Report and SQL historical database queries of the historical database.

The data collection and storage system(s) shall provide the following additional features:
Any system variable (I/O point, calculated variable, etc.), system message, or file (alarm list, periodic report, SOE report, etc.) shall be available for storage.

Ability to execute periodic summary calculations, such as average value, minimum value, maximum value, summation, or runtime shall be User selectable on a per point basis.

Storage of additional parameters such as point description, engineering units, scaling information, and alarm limits shall be User selectable on a per point basis.

Storage of control function block parameters (set point, deviation, block output) shall be User selectable on a per block basis.

The system hardware and software shall be sized to allow collection and permanent storage as defined in Section 17500. The permanent storage medium shall be optical disk, CD-ROM, or DVD as defined in Section 17510. All Operator interfaces to the disk subsystem shall be menu driven with any special command structures transparent to the Operator. Data shall be automatically written to disk provided the storage medium is in a condition to receive data; otherwise, an alarm message shall be generated.

SUPPLIER shall furnish all consumables (optical disks, CD-ROMs, DVDs, etc.) required for long-term data storage as specified in Section 17510.

2-2.10. System Equipment. The equipment shall be provided as specified herein and in Section 17500.

SUPPLIER system shall allow all cards or modules to be removed for maintenance while under power without causing damage to the card/module or to the system, or shall allow for power down of one of a redundant pair of modules to allow its removal for maintenance.

2-2.10.01. Communications Networks. The DCS communications networks shall conform to the following criteria.

2-2.10.01.01. Data Highway Communications Network. The system communications networks shall continue to utilize a redundant Control Processor to Control Processor data highway communications network. The redundant communications equipment shall include cable adapters and connectors, modems, line drivers, switches, network

hubs, fiber optic patch panels and fan out kits, receivers and transmitters required by SUPPLIER design.

The capability shall be provided for connection of future nodes to the data highway communications network, such as additional Control and Operator Interface Processors, monitors, programming devices, or foreign device interfaces to other systems. The data highway communications network shall be expandable to accept at least 100 percent future additional nodes. The system shall be designed so that new nodes can be added without shutting down the system or causing a loss of control, information display, or alarm information. The data highway communications network shall not be dependent on any master controllers for its operation.

2-2.10.01.02. Operator Interface Communications Network. The system communications networks shall also include an operator interface communications network for data transfer from the data highway communications network to the Operator and Operator/Engineer interface equipment. The communications network shall include any cable adapters and connectors, modems, line drivers, switches, network hubs, fiber optic patch panels and fan out kits, receivers and transmitters required by SUPPLIER design for communication to the Operator Interface Processors, monitors, keyboards and printers.

The operator interface network shall be designed such that a failure of any Operator Interface Processor, or the failure of any part of the operation interface communications network, shall not cause the loss of more CRT monitors than the total number of CRT monitors specified per work station. Each node of the operator interface communications network shall be able to communicate peer-to-peer with the others. The operator interface network shall be designed to allow for expansion.

Prior to shipment SUPPLIER shall permanently mount all operator interface communications network equipment, not located at the Operator Work Stations, in system electronics cabinets on shelves or racks. Power for the cabinet's internal components shall be internally wired, by SUPPLIER, from redundant power sources. SUPPLIER may provide power from redundant internal power supplies, or from redundant surge-suppressing power strips; each fed from a separate source. If power strips are used, the strips shall be wired by SUPPLIER to terminal blocks for customer furnished power feeds, and to the cabinet's internal components. Redundant network components shall be connected to separate, or redundant, power sources.

All operator interface communications shall be via an Ethernet network conforming to the following additional requirements:

Ethernet networks shall, at a minimum, conform to the requirements of IEEE 802.3, 100Base systems. SUPPLIER shall be fully responsible for the design and implementation of the network. The network design shall be done by a qualified network engineer, with the final design of the network acceptable to the OWNER

and ENGINEER.

Ethernet networks shall provide connectivity to existing plant networks and shall be compatible with slower equipment that may be connected to the network. The network must be designed such that these connections to external networks shall not degrade the performance of the DCS Ethernet networks.

All Ethernet based communication networks shall use unshielded twisted pair (UTP) and/or fiber-optic cable. Twisted pair cable networks shall conform with ISO 8802.3 10/100BASE-T Category 5e or newer requirements. Fiber-optic cable networks shall conform with ISO 10/100BASE-FL (FX) or newer requirements.

Maximum network segment lengths shall conform to the IEEE 802.3 standard requirements.

Bit-shift delays and interframe gap shrinkages shall conform to IEEE 802.3 guidelines, particularly for complex multi-segment system designs.

Ethernet networks shall use a port switched configuration with redundant network hardware, and shall minimize the use of non-switching hubs.

Switches shall be auto-sensing with remote management capability.

Switch ports shall be capable of both 10 megabits per second (Mbsp) and 100 Mbsp operation, full and half duplex.

Switches shall include a spanning tree algorithm compatible with IEEE 802.1D to protect against inappropriate network loops.

Rack mounted equipment shall be supplied where ever possible.

2-2.10.01.03. I/O Communications Network. An I/O communications network, for data transfer from the Control Processors to the I/O, shall also be included in the system communications networks. The communications shall include any network cable, modems, receivers, and transmitters required by SUPPLIER design.

2-2.10.02. Control Processors. All Control and Data Acquisition Functions shall be implemented by modularized distributed Control Processors without the use of any disk drives. All Control Processor modules shall be of the manufacturer's standard design and shall be identical in terms of their physical hardware, to the greatest extent possible, to minimize the number of types of Control Processor modules.

Control Processors shall be self-booting and shall be designed to automatically receive configuration information from the system server via the data highway communications network when initially installed or after a power loss resulting in loss of configuration

memory. Each Control Processor shall contain a complete library of control function algorithms stored in nonvolatile memory. Each Control Processor shall utilize these algorithms along with its unique configuration information to implement its process control functions. Control Processors shall be designed for multi-segment operation, such that a minimum of five program segments can run independently at individual User selectable scan rates.

Control Processors specified to have redundancy shall have a pair of completely duplicate Control Processors, connected separately to the data highway communications network. One member of the Control Processor pair shall be active; the other member of the pair shall be operating in a continually updated, hot standby mode. In the event of a failure in the active member, all functions shall immediately be assumed and conducted by the standby member, which shall then function as the active Control Processor. Redundant Control Processors shall utilize a state replication model, such that the standby Control Processor begins executing at exactly the same point in the program scan cycle as the primary Control Processor was when it failed. When the failed Control Processor is replaced or reactivated, it shall automatically assume the function of the hot standby Control Processor. The assignment of the active and hot standby mode for the pair shall be User selectable, with a method for switching operating modes between the pair without interrupting system control functions.
Each Control Processor shall be assigned a specific Control and/or Data Acquisition Function. Assignment of functions to the Control Processors shall be acceptable to the Engineer and OWNER.

The minimum level Delta V controller family permitted is the Type MD controller.

2-2.10.03. System Input and Output Equipment. Input and output equipment shall be furnished as required by Section 17500. Field powered inputs and outputs (I/O) shall be electrically isolated from each other (no common hot, neutral, or return connections) and from all cabinet wiring. All I/O modules shall meet the requirements of ANSI Standard C37.90.1-1989 for surge withstand capability. All required peripheral equipment for signal conditioning, impedance matching, balancing, and other similar functions shall be furnished and installed by SUPPLIER.

SUPPLIER shall fully configure, prior to system shipment, all I/O modules to match the I/O type as specified in the I/O database. This hardware configuration shall include, but not be limited to, the installation of all dip shunts, dip switches, and jumpers.

The I/O modules shall be connected directly to the individual Control Processors so that a failure of the data highway communications network will not affect the availability of the I/O necessary for execution of the control functions of the system.

All I/O modules shall include User configurable fail-safe mode selection to allow individual selection of module response to Control Processor data highway communications network or I/O communication network failures.

I/O rack slots shall accept either input modules or output modules of any type as required. I/O modules shall be replaceable without removing any field wiring.

Digital I/O interrogation power switching shall be as defined in Section 17500.
All inputs and outputs required by SUPPLIER to implement the specified scope of the system shall be provided in addition to the quantity of inputs and outputs specified under I/O Requirements in Section 17500. These inputs and outputs shall include, but not be limited to, the following:

- Power supply voltage checks.
- Power supply failure alarms.
- Cabinet cooling fan failure alarms.
- Cabinet temperatures.
- Cabinet temperature alarms.

2-2.10.03.01. Digital Inputs. Any required additional DCS digital input equipment (not included as part of new PLC-based controllers) shall be used to monitor the status of field contacts or voltage sources representing control or information intelligence in the form of digital (on, off; "1," "0") logic. SUPPLIER Digital inputs and SOE Digital inputs must each meet the following requirements.

Sensing circuitry for digital inputs shall have high input impedance. Individual status lights shall be provided for each input on all digital input modules. Status lights shall monitor the logic side of the input rather than the field side.

The system shall allow the User to individually select the input interrogation voltage source for each digital input on each card. The available interrogation voltage sources shall include the following as a minimum:

- DCS internal system I/O interrogation power (contact sensing).
- Equipment-supplied external contact voltage (voltage monitoring).
- Equipment-supplied SUPPLIER-routed power (contact sensing). Routed power is internally wired in the I/O cabinets by SUPPLIER as specified in Section 17500.

Section 17500 defines the requirements for new PLC-based controller(s) in each location.

The field circuit cables used for digital inputs will be unshielded control cable and will be routed in 120 volt ac circuits. The digital input cards for use with ac interrogation voltage shall be designed such that they are impervious to the effects of capacitive

coupling in the field cables to the point that they allow the input module circuitry to effectively differentiate between the closed and open states of the field contact. The use of external pull-down resistors is not allowed.

Digital inputs shall be provided with contact bounce filtering. The filter shall delay digital inputs to protect against input device bounce and electrical noise on input lines.
All digital inputs shall be protected from electrical surge using external plug-in type (dual channel maximum per plug-in surge protector) DIN-rail mounted surge protection devices. Surge protection devices shall be Phoenix Contact 'PT Series' or ENGINEER and OWNER pre-approved equal.

2-2.10.03.02. Digital Outputs. Any required additional DCS digital output equipment (not included as part of new PLC-based controllers) shall be used to provide control intelligence (mechanical or solid-state contact) to field devices requiring digital (on, off; "1," "0") commands.

Individual status lights shall be provided for each output on all digital output modules. Status lights shall monitor the field side of the output rather than the logic side. Where individually fused outputs are provided, each output shall be provided with a blown fuse indicator.

Digital output modules shall be rated for the loads as required per Section 31500. SUPPLIER shall furnish and install within the DCS cabinets interposing relays with a minimum of one Form "C" contact designed to provide the load capability defined in Section 17500. Where additional contacts are required, additional parallel interposing relays shall be provided for the digital output. Interposing relay coils shall be powered by the DCS outputs.

Where fail-safe digital outputs are required to safely shut down equipment or to enable backup control of equipment on a DCS failure, SUPPLIER shall provide the necessary fail-safe logic relays in his I/O cabinets. The relays shall be provided with a minimum of one Form "C" contact rated to switch the load of the driven equipment.

The quantity of interposing and fail-safe relays required shall be as specified in Section 17500.

Digital outputs may be used to switch inductive loads and these inductive loads may be interrupted by external contacts. All required transient protection shall be internal to the output module. Triac switches are acceptable for ac outputs; however, the triac output shall have a low minimum loading current so that they can be utilized to drive high impedance devices such as PLC inputs and neon lamps. Outputs shall not require the use of external load resistors or pull-up resistors.

The system shall allow User to individually select the output power source for each digital output on each card. The available power sources shall include the following as a minimum:

- DCS internal system I/O power (wetted contact).
- Equipment-supplied external contact voltage (dry contact).
- Equipment-supplied SUPPLIER-routed power (wetted contact). Routed power is internally wired in the I/O cabinets by SUPPLIER as required per Section 17500.

Section 17500 defines the requirements for new PLC-based controller(s) in each location.

2-2.10.03.03. Analog Inputs. Any required additional DCS analog input equipment (not included as part of new PLC-based controllers) shall utilize analog-to-digital converters with a minimum accuracy and resolution of ±0.15 percent of full scale.

DCS Analog input modules shall accept all ranges of inputs listed in Section 17500 from thermocouples, RTDs, analog transmitters, slide wires or any dc current or voltage signal from a process transducer. If SUPPLIER I/O modules cannot accept a signal type and range listed in the I/O list, SUPPLIER shall furnish, install, and wire in his I/O cabinet a signal conditioner with the proper input and output ranges to convert the field signal to a level acceptable to SUPPLIER system. Precision resistors shall be furnished by SUPPLIER as an integral part of the analog input system.

An input filter shall be used to attenuate any high frequency noise components which may be coupled with the signal. Low pass filtering shall cut off at a maximum of 2 hertz. Common mode noise rejection shall be a minimum of 110 dB at 60 hertz. Normal mode noise rejection shall be not less than 60 dB at 60 hertz. Series mode signal-to-noise rejection ratio shall be not less than 1,000 to one for thermocouples and other low level signals.

The removal of analog input cards for service or maintenance shall not affect the continuity of current type input field circuits.

Thermocouple input cards shall be designed so that different thermocouple types can be mixed on each card and shall be designed to accept field grounded thermocouple circuits.

The system shall allow the User to individually select the transmitter power source for each analog input on each analog input module. The available power sources shall include DCS internal system I/O power (system powered), and transmitter supplied power (field powered). The analog input modules shall provide electrical isolation between field powered and system powered inputs. Transmitter circuits shall be

individually fused, isolated using external (single channel) isolators, and protected from surge using dual-channel (maximum) external DIN-rail mounted surge protectors.

Analog signal isolators shall be Phoenix Contact MCR-CLP-UI/-4 or ENGINEER and OWNER approved equal. Analog input surge protectors shall be DIN-rail mounted plug-in type (maximum dual channels per plug-in surge protector) 'PT-series' as manufactured by Phoenix Contacts or ENGINEER and OWNER approved equal.

2-2.10.03.04. Analog Outputs. Any required additional DCS analog output equipment (not included as part of new PLC-based controllers) shall have drift characteristics which meet the system accuracy guarantees. The output of all digital-to-analog converters shall have an accuracy and resolution of ±0.25 percent of full scale of the signal. Analog outputs shall produce 4 to 20 mA dc current loops capable of driving 750 ohm loads.

Any required DCS Analog outputs shall be used for control (to position valves, dampers, etc.) and for information (to drive indicators, recorders, etc.) as noted and defined in Section 17500.

The analog output modules shall provide electrical isolation between field powered and system powered inputs. Transmitter circuits shall be individually fused, isolated using external (single channel) isolators, and protected from surge using dual-channel (maximum) external DIN-rail mounted surge protectors.

Analog signal isolators shall be Phoenix Contact MCR-CLP-UI/-4 or ENGINEER and OWNER approved equal. Analog output surge protectors shall be DIN-rail mounted plug-in type (maximum dual channels per plug-in surge protector) 'PT-series' as manufactured by Phoenix Contacts or ENGINEER and OWNER approved equal.

2-2.10.03.05. Pulse Inputs. Pulse input cards shall receive pulse inputs in the form of contact closures occurring at a rate which will not exceed 2,000 pulses per second. The pulses shall be those typically output by watt-hour measuring equipment.

2-2.10.03.06. Foreign Device Interfaces. New FBM-232 Field Device System Integrator (FDSI) module to enable "bridging" communication between Foxboro DCS to new ICWRC Headworks, ICWRC Screen 1, ICWRC Screen 2, ICWRC Transfer Pump Station, SRWRC Chemical Dosing, and SRWRC Headhouse Allen Bradley / Rockwell Automation Controllogix PLC-based controls.

2-2.10.03.07. Fiber Optic Cable. Fiber optic cable is detailed under Section 17591.

2-2.10.03.08. Fiber Optic Communications Hardware. CONTRACTOR shall provide all necessary fiber optics transceivers and modems for the DCS. Communications hardware is detailed under Section 17590 and shall meet the requirements of the manufacturer of the DCS.

2-2.10.4. Operator Work Stations. Three (3) existing Operator Work Stations shall be replaced as indicated under 1-1. Items 2 & 3 and as shown on plans. Each Operator Work Station shall consist of monitor(s), Operator keyboard(s), pointing device(s), and supporting electronics (Operator Interface Processors, display generators, data highway communications network equipment, etc.).

Each Operator Work Station shall be designed for interactive Operator capability for the following functions, including but not limited to:

Provide point and click actions required for the Operator to interact with the system, such as cursor positioning, display selection, menu selection, menu item selection, etc.

Select and execute process and equipment control functions, including but not limited to, start, stop, raise, lower, auto, manual, alarm acknowledge, etc.

Select any display to any monitor, and select display combinations of process control displays, trend displays, group displays, and bar chart displays on any monitor.

Select points and assign parameters for trend displays, group displays, and bar chart displays.

Assign points, collection periods, and print periods for reports and data storage functions.

Enter numerical values and alphabetic characters.

Copy any display to color hard copy (paper).

The operation interface communications network and each Operator Work Station shall be designed to include, at a minimum, the following physical characteristics:

The operations interface communications network shall be designed such that all Operator Work Stations have physical and logical redundant data paths to the data highway communications network.

Each work station shall include key lock and/or password protection to restrict access to critical functions to be performed by authorized personnel only. These functions will be defined by the Engineer and OWNER during the design phase of the project.

Each work station shall include, at a minimum, 16-bit, CD quality audio capabilities, including speakers mounted integral to the LCD display.

Work station electronics and all other equipment with a noise level of 55 dBA or greater at 3 feet shall be installed in system cabinets to be located in the same room as the system electronics cabinets.

All LCD monitors shall be designed to minimize reflection and glare from external light sources.

All LCD monitors shall have a maximum dot pitch of 0.28 mm and a resolution of at least 1280 by 1024 pixels with a minimum refresh rate of 75 hertz.

All monitors of like size shall be physically interchangeable.

Controls shall be provided on the front of each monitor for contrast, brightness, and degauss as a minimum. Microprocessor based on-screen-display shall also be provided for H-phase, H-size, V-center, V-size, pincushion, trapezoid, RGB mode, and color temperature as a minimum.

Monitor radiation emissions shall comply with existing industry standard requirements.

High quality LCD monitors, with convergence at the edges of the screen equal to that at the center, shall be provided, since messages are written to the extreme left and right sides of the screens,

Operator keyboards shall be membrane type with modular plug-in construction to allow quick replacement.

Operator keyboards not located in controlled environments shall be sealed membrane type with integral touchmouse and modular plug-in construction to allow quick replacement.

2-2.10.05. Engineer/Operator Work Stations. The existing Engineer / Operator Work Station shall be replaced as indicated under 1-1. and as shown on plans. Engineer/Operator Work Station shall consist of monitor, QWERTY keyboard, pointing device, and supporting electronics (Operator Interface Processors, display generators, data highway communications network equipment, etc.).

The Engineer/Operator Work Station shall be designed to include, at a minimum, the following physical characteristics:

Each work station shall be able to monitor, view, create, modify, debug and document any control or information display, program, database, or other function within the DCS.

Each work station shall include the capability to provide both on-line and off-line development of control and data acquisition programs and control and information display development.

Each work station shall include key lock and/or password protection to ensure that unauthorized program entry and alteration cannot occur.

Each work station shall include a hard disk for program and display storage and one or more floppy disk or CD-ROM drives for program backup, loading, and storage in accordance with 1.1.1.2 and Section 17500.

The Engineer/Operator Work Station shall provide all the functions of a full-featured Operator Work Station.

2-2.10.06. Printers. Not Required.

2-2.10.08. Operator Control Console. Not Used.

2-2.10.09. System Cabinets. Existing computer equipment racks and DCS equipment field cabinets shall be modified as required to incorporate I/O replacement detailed in 1-1. Item 4 and as shown on plans.

2-2.10.11. Time Synchronization Equipment. Not Used.

2-2.10.12. Interconnecting Cables. As required by Section 17500 (unless specifically excluded), SUPPLIER shall provide all interconnecting cables, such as, data highway communications network, remote I/O communications network, and Ethernet, (metallic or optical fiber) required for connections between the various physically separated items in his scope of supply. Metallic and fiber optic cable using plug-in connectors shall be completely fabricated and tested by SUPPLIER and shall be used to interconnect the system during the factory tests. Metallic cables using terminal block connections shall be provided as bulk lots of cable, on reels.

2-2.10.13. Installation and Maintenance Equipment. Where required, SUPPLIER shall furnish two sets of all special tools and equipment used in installing, modifying, and maintaining the DCS equipment. All tools and equipment will be used during system checkout and startup and will be the property of the OWNER.

Installation and modification tools shall include, at a minimum, all tools necessary to duplicate the interconnection method used to fabricate assemblies, such as wire wrap tools; tools required to crimp, insert, or remove pins from any connector supplied; and all tools required to insert or remove EPROMs, dip shunts, or any other removable circuit board components.

In addition, maintenance tools shall be provided to supplement and monitor hardware diagnostic test programs. The maintenance equipment shall include all devices required to perform the hardware diagnostic testing in a manual or off-line mode. This shall include, if required by the system, each type of extender board needed to access circuit boards or cards.

2-2.11. System Power and Grounding.

2-2.11.01. Power Sources for System Use. Existing power source(s) shall continue to be utilized for all replacement DCS I/O and field equipment.

2-2.11.02. Power Distribution. SUPPLIER shall be responsible for any modifications to DCS internal power distribution system required as part of DCS I/O and field equipment replacement.

2-2.11.03. System Power Supplies. SUPPLIER shall provide and install within his systems all replacement power supplies or upgrades to existing power supply equipment required to transform, regulate, condition, isolate, and rectify the plant's power sources for use by the system as part of Foxboro DCS I/O and Foxboro field equipment replacement and expansion to support new PLC-based networks.

2-2.11.04. Battery Backup. The use of batteries shall be minimized. Where battery backup of memory is required, the batteries shall be sized to retain this memory for a minimum of 48 hours. All batteries shall be replaceable without any interruption of the function for which the battery provides backup.

2-2.11.05. System Effects on Power Sources. SUPPLIER systems shall be specifically designed to strictly limit any effects fed back from systems into the power source wiring. The power supply inputs shall have a linear curve for consumed current versus voltage from 10 to 100 percent load. Power supplies which create reflected current harmonics shall have input filters to limit the total harmonic distortion to less than 2 percent, and a wave form crest factor ratio of peak to rms current that does not exceed 3.

2-2.11.06. System Grounding. Where required as part of DCS modifications, SUPPLIER shall include new electrical, system, or logic grounding to the plant ground grid at a single connection point. The Contractor will furnish insulated ground cable from this point on the plant ground grid to the system cabinets. The insulated ground cables will be connected to an insulated copper grounding busbar which shall be provided by SUPPLIER in each cabinet.

The system cabinets shall be equipped to accept the insulated ground cables, which at this point will be isolated from the building ground. Any internal component grounds or commons shall be connected to the system ground, which shall be kept isolated from the building ground.

Any required electrical ground or common from components not mounted in the system cabinets shall be brought to a terminal block connection within that component. This terminal block connection shall be located with the other terminals within the component and shall be available for connection through the shield of the field wiring to the system ground bus within the associated system cabinet. Isolation between building ground and system ground shall be inherent in the component design.

Each cabinet structure will be safety grounded to building steel. SUPPLIER shall provide separate connection points within each cabinet for attachment of cables to the building ground.

At least 600 volt isolation shall be provided between the electrical, system, or logic grounding busbar and cabinet or building ground for all system components.

When shielded terminations are required in cabinets furnished under these specifications, suitable terminals and supports shall be furnished adjacent to input terminals. Cabinet wiring by SUPPLIER shall include connection of the shield terminals to the grounding busbar. SUPPLIER shields shall be provided with insulating sleeves to prevent contact of the shields with the metallic structure.

SUPPLIER shall provide connectors in each cabinet for connection of the system ground and the safety ground. The connectors shall be sized to allow connection of 2 AWG field ground conductors.

2-2.12. Software. A complete set of software program packages shall be provided to implement the functions of the DCS. SUPPLIER shall be responsible for developing, debugging, and testing all software provided with the DCS.

SUPPLIER shall grant to the OWNER and/or end-user licenses to use all software provided with the DCS for monitoring and control of the plant systems and equipment that constitute the project. The license shall include the right to make backup copies of all software provided by SUPPLIER. The license fees shall be included in the DCS price.

The DCS shall include the following major software components:

- Operating system software programs to provide all Control and Data Acquisition Functions.
- Application builder tool programs for development and modification of control and data acquisition programs.
- Application builder tool programs for development and modification of control and information displays.
- Application builder tool programs for development and modification of the system database.

- Application builder tool programs for development and modification of performance calculations and other specialized data manipulation.
- Application builder tool programs for development and modification of reports.
- Application software for control and information.
- System database for identification of all process (I/O) and calculated variables (points) and for definition of the system attributes associated with each point.
- Diagnostic programs to perform on-line testing functions for system hardware and software.
- Custom and third-party application programs as defined in Section 17500.

2-2.12.01. System Operating Software. The DCS operating system software shall conform to the following criteria.

2-2.12.01.01. Communications Networks. The DCS shall include a distributed data highway communications network operating system designed for mission critical process control applications requiring real-time data transmission without loss, degradation, or delay, even during plant upsets. The system shall be designed to ensure the reliability, security, and performance of the data highway communications network. The use of current off-the-shelf technology and protocols for the data highway communications network is encouraged. The network software shall support fault-tolerant communications including network management and diagnostics, fault detection, and fault recovery and management. The software shall support peer-to-peer communication between all nodes. The system shall calculate and display data highway communications network loading, free time, and communication failures and retries. The system software shall be designed to allow the data highway communications network to be easily expanded on-line by the addition new nodes.

2-2.12.01.02. Control Processors. The DCS Control Processors shall include Real-Time Operating System (RTOS) software specifically designed for real-time process control and communications functions. The RTOS shall support multi-tasking and preemptive task scheduling. The RTOS shall allow multiple application areas to execute at separate frequencies. The system shall contain hardware and software security features which prevent incorrect control actions from occurring as a result of hardware malfunctions or software errors. The system shall calculate and display Control Processor loading, free time, and continuous running hours.

The following DCS data shall be saved on a Control Processor reboot shutdown, failure, or power loss. The data shall be automatically restored to active memory on Control Processor restart for use in all programs, calculations, displays, and reports.

- Pulsed input accumulations.
- Running, periodic, hourly, daily, monthly, and weighted averages.

- Periodic, hourly, and daily minimum and maximum values.
- Hourly and daily report totals.
- Status of devices which have been “tagged out”.
- Current process set-points and operating parameters.

2-2.12.01.03. Foreign Device Interfaces. SUPPLIER shall provide all support software, including server and client software, and all drivers to communicate with Contractor-furnished foreign devices, such as personal computers and programmable logic controllers (PLC) as defined in other Sections.

The communications system utilized shall be based on the ISO Open Systems Interface (OSI) model to assure connectivity between different systems. The communications system shall be implemented using Ethernet (100 Mbps or Gigabit) standards for the hardware layer. The communications interface shall be bi-directional, capable of receiving and originating messages over the communication network.

All Ethernet based communications networks shall conform to IEEE 802.2 (ISO 8802.2) and IEEE 802.3 (ISO 8802.3). The Ethernet communications network shall communicate at minimum 100 megabits per second. The network driver shall be selected to match the hardware configuration of the network. As a minimum, the network operating system shall support the TCP/IP communication protocol suite. The system shall support standard real-time data interchange protocols, such as, OPC (OLE for Process Control), Modbus TCP, and NetDDE to allow easy integration of plant data with applications including business, SCADA, HMI, and other custom software packages.

2-2.12.01.04. Operator and Engineer/Operator Work Stations. The operator and engineer work stations shall utilize a commercially available and supported Microsoft multitasking operating system. The operating system shall provide the interface to the process through control graphic displays, alarms, trends, and diagnostics.

The operating system shall support standard applications interfaces, such as, OPC, ODBC, and NetDDE, which allow real-time and historical DCS data to be passed to compliant third-party client software packages across the plant LAN/WAN and vice versa. The operating system shall also support single or dual monitors, multiple languages, character sets, and cultural conventions.

In addition, the system operating software shall meet the following criteria:

The software shall supervise all aspects of software installation processes including checking memory for defects, testing system hardware, and procedures for installing individual programs.

The software shall reinitialize the system following a memory failure or long-term power failure. The re-initialization software shall contain necessary functions to

allow the User to install all operating system and application software onto the system memory with a series of screens displaying guidance messages throughout the entire installation process.

The system shall include security features designed to limit access to critical information and plant control features to authorized personnel.

The system shall support standard Microsoft or X-Terminal Windows protocol to allow DCS control and information displays to be accessible and functional on any interconnected remote system through use of Microsoft Terminal Services.

The system shall provide a “windows” graphical-user-interface (GUI) using desktop menus and icons for user access to all control, monitoring, and engineering functions.

The system shall be based on technology which allows multiple windows that can be moved and resized. This resizing must resize, not just crop, the window's display.

The system shall include software and associated licenses shall be provided to allow, a minimum of, four simultaneous displays to be opened on each Operator Work Station.

2-2.12.02. Application Builder Tools. High level application builder tools shall be provided to create and modify all system configurations including control and data acquisition programs, displays, databases, performance calculations, and reports. The User shall be able to create or make modifications to any system configuration in a conversational mode, using fill-in-the-blank, pull-down menus, or other similar techniques from any Engineer/Operator Work Station. The application builder tools shall be available only in the engineering environment of the system under password or key lock control. The system shall provide facilities for self-documentation of all system configurations.

The Engineer/Operator Work Station and its attendant software shall be self-contained to support all reconfiguration work including downloading functions from the Engineer/Operator Work Station to the Control and Operator Interface Processors with the DCS on-line.

Any system display which is reconfigured, updated, or altered shall be automatically downloaded to each work station which incorporates the display with a single download command.

The system shall provide the capability to create or edit all configurations in either an on-line or off-line mode. On-line editing capabilities shall be designed to prevent loss of control of the process during the editing process. All off-line application builder tools

shall include printer drivers to allow database reports, control configuration drawings, and color control and information displays to be printed on any network connected printer.

2-2.12.02.01. Control And Data Acquisition Program Editor. Each Engineer/Operator Work Station in the system shall include a complete set of User-friendly interactive editors for generation and modification of control and information programs. The editors shall be of the latest technology including a mouse driven graphical user interface (GUI) using windowing technology (i.e., drag/drop, cut/copy/paste, etc.). The method of configuring, modifying, and documenting control and data acquisition strategies shall be such that it can be readily understood and used by Engineers/Programmers and Technicians.

2-2.12.02.02. Foreign Device Interface Program Editor. Each Engineer/Operator Work Station in the system shall include a complete set of User-friendly interactive editors for modification of the programs for each type of foreign device interface specified in other Sections. The editors shall be of the latest technology including a mouse driven graphical user interface (GUI) using windowing technology (i.e., drag/drop, cut/copy/paste, etc.). The method of configuring, modifying, and documenting the foreign device interface strategies shall be such that it can be readily understood and used by Engineers/Programmers and Technicians, and shall be designed so that the OWNER, can easily re-configure the selection of data to be transferred between the DCS and the foreign device. The command and address attributes required for this configuration shall be straightforward and shall not require extensive mathematical calculations or programming.

2-2.12.02.03. Control and Information Display Editor. The system shall permit the User to use the Engineer/Operator Work Stations to create or modify control and information displays and request that the system store the displays. This capability shall enable the User to expand the information to the Operator as experience and needs dictate. These displays shall be storable in a form portable to future systems or expansions.

The system shall permit the User to specify any control or information display to be viewed in response to a selected point(s) changing status.

Each Engineer/Operator Work Station in the system shall include a complete set of User-friendly interactive control and information display editors for generation and modification of the displays, macros, custom shapes, and custom colors. The editors shall be of the latest technology including a mouse driven graphical user interface (GUI) using windowing technology (i.e., drag/drop, cut/copy/paste, etc.). The interactive editors shall allow the User to build, inspect, or modify any display using any or all of the textual, geometric graphic, or symbolic features of the system. New displays shall be able to be created starting from a blank screen or by recalling existing displays, editing, and storing the new display under a new file name.

The system shall allow the User to create and store frequently used shapes and symbols representing plant and process equipment. These symbols shall be available for use in any process control display. The symbols shall have the capability to be located at any place on a display, to be rotated to any orientation, to be magnified or reduced, to be given any color, and to be dynamically linked to any system variable. The system shall include a library of SUPPLIER standard set of geometric symbols (similar to ISA S5.5 symbols) related to power plant equipment. The system shall provide the capability to save User defined groups of geometric graphic elements as macro symbols which can then be imported into other process control displays.

Off-line control and information display editors including all of the features previously listed shall be available for use on any personal computer. SUPPLIER shall furnish this software in the quantity specified in Section 17500, at the start of the project, for installation on the OWNER personal computer(s). Control and Information displays created or modified off line shall have all the features and capabilities as those created or modified using the on-line tools.

2-2.12.02.04. System Database Editor. SUPPLIER shall provide the latest available Foxboro DCS database editor which allows deletion of existing computer points, addition of new computer points, examination of all existing computer points and their parameters in the data files and addition, deletion, and modification of these parameters by interactive, conversational, cross-linked, high level software through any Engineer/Operator Work Station under password or key lock protection. The editor shall have the capability to modify data point parameters while the data highway communications network and Control and Operator Interface Processors are on line, without any disruption of control and/or interlock functions. The editor shall have the capability of modifying any or all database point parameters. The editors shall utilize the latest technology including a mouse driven graphical user interface (GUI) using windowing technology (i.e. drag/drop, cut/copy/paste, etc.).

The database editor shall be able to retranslate the system database back into the original format of the Control System's I/O list. The retranslated I/O list shall reflect all additions, deletions, or modifications made to the system database while on line.

Off-line database editors including all of the features previously listed shall be available as a part of the control and data acquisition program editor and/or the control and information display editor. If off-line database editors are not included in these editors, SUPPLIER shall furnish these editors in the same quantity as the control and information display editor as specified in Section 17500. These editors shall be supplied at the start of the project, for installation on the OWNER personal computer(s).

2-2.12.03. Applications Software. High level application-oriented languages shall be used for all communication, control, and data acquisition programs. These languages shall contain algorithms to accomplish all the logic functions commonly used in utility power plant control and information systems.

The language design shall be such that field modifications to any of these programs can be rapidly accomplished by the User.

The application languages shall be supported by an operating system capable of scheduling and executing a program or series of programs on a periodic basis or upon the occurrence of some predefined event. The languages shall include the facility to utilize all normal system functions for display, reporting, trending, alarming, etc., for all system variables, including intermediate variables. SUPPLIER shall supply all standard formulations required such as thermodynamic properties, thermocouple linearization, resistance temperature detector curves, etc.

The software shall have the following capabilities:
A high level language which shall be used to build programs which will run at selectable time intervals.

Provision to specify individual high level language coded routines which shall be executed when any alarm or any return-to-normal message occurs on a per analog or calculated point basis.

Provision to specify individual high level language coded routines which shall be executed when a contact change occurs on a per point basis.

2-2.12.03.01. Control Programs. All Modulating Control programs implemented in the PLC-based controls shall be developed by using a building block approach. The basic building blocks shall be constructed from control algorithms commonly used to perform Modulating Controls and Discrete Controls in utility power plants. All program configuration and modification functions shall be able to be accomplished with the system on-line without affecting the operation of any of the control subsystems.

The Discrete Control logic in the PLC-based controls shall be programmed in ladder diagram or function block format. If the control strategy of a control subsystem requires both Modulating Control and Discrete Control, the two types of control functions shall be integrated and executed as a single program.

2-2.12.03.02. Information Programs. Information programs shall be designed to support all data acquisition, information management, and Operator interface activities of the system, including, as a minimum, the following:

- Input/output data processing.
- Database management.
- Alarm checking and reporting.
- Performance calculations.
- Control and information displays.
- Reporting, report writing, and spreadsheet.
- Data storage.

- Software configuration.
- Operator interface.

The programs shall be designed to support commonly used high level languages such as FORTRAN, C+/C++, Visual Basic, ActiveX, and Java to be used for User-written programs. The manufacturer's standard programs shall be used. However, the programs shall be organized into easy-to-identify and easy-to-use packages on a functional basis to be run either independently or, if necessary, in conjunction with other programs. The Operator interface software package shall be designed to provide a uniform work procedure for all Operator interface devices, and all interface activities shall be menu driven with "help" functions, conducted in an interactive and conversational mode. This software shall be designed to be easily understood by Operators and Engineers/ Programmers with no expertise in computer systems.

2-2.12.03.03. Databases. An I/O list database will be developed to allow design information transmittal between the Engineer and SUPPLIER. A system database shall be developed that will allow access of the I/O by the control system.

In the databases, a unique identifying code (tagname) shall be assigned to each analog, digital, calculated, data linked, or manually inserted point, by which the point may be referenced by both the Operator and the system. The code shall consist of at least 12 alphanumeric characters. The code format shall be as determined by the Engineer and OWNER and shall not be subject to any SUPPLIER requirements.

2-2.12.03.03.01. I/O List Database. The Engineer will provide initial information, including the tagname, functional point description, and electrical characteristics for the process I/O, using a commercially available database program in an agreed upon format. After the initial I/O list database submittal by the Engineer, SUPPLIER shall be responsible for maintenance of the database until the system is shipped to the project site.

SUPPLIER shall add I/O card and termination information to the database. In addition to providing information on active I/O, SUPPLIER will populate the database with the hardware information for all available spare points on all cards. The database will them be submitted to the Engineer for review. The I/O termination locations shall be acceptable to the Engineer and OWNER and shall be in an arrangement which will assure that functional and electrical characteristics are matched. The I/O termination locations shall not be selected in an order solely to satisfy SUPPLIER requirements.

SUPPLIER shall compile a request list for alarm parameters, data storage requirements, and similar information to be provided to SUPPLIER by the OWNER and Engineer during detailed design. The OWNER and Engineer may from time to time provide other additions or revisions to the database which SUPPLIER shall incorporate into the master database. The additions or revisions may be in hard copy or electronic format.

At the time of shipment, SUPPLIER shall furnish an as-shipped I/O list database to the Engineer and OWNER. The as-shipped database shall be in the same format as the initial I/O list database provided by the Engineer and OWNER.

SUPPLIER shall use the I/O list database to generate the system database.

2-2.12.03.03.02. System Database. SUPPLIER shall provide an updated system database covering all system points and their attributes. The database organization shall be a standard database format, so that a point shall be stored as a file record and the attributes of that point shall be stored in the file as fields.

Each point shall be supported by a set of parameters which represent the point properties. Typical point parameters shall include, but shall not be limited to, tagname functional point description, engineering units (Analog Points), state descriptions (Digital Points), scan rate, alarm limits, and value.

2-2.12.04. Diagnostic Programs. Diagnostic programs shall be provided for the following diagnostic tests:

- Initiation checks.
- On-line diagnostics.

The initiation checks shall be initiated each time power is applied to a Control or Operator Interface Processor. These checks shall monitor the startup sequences of the Processor to ensure that the Processor has been successfully powered up and in the proper working condition.

The on-line diagnostics shall be executed automatically during normal on-line operation of the Control and Operator Interface Processor, providing continuous monitoring of the Processor functions, including, but not limited to, logic processing, I/O processing, memory functions, and communications functions. Data highway communications network, controller, card, and error status information shall be available and the system shall present this information in English terms. Cross-referencing of numeric values to a diagnostic manual for initial problem determination is not acceptable.

Hardware diagnostic test software shall be provided for the following computer equipment. These diagnostics shall include fault analysis to the circuit board level:

Distributed processing units.
Memories.
Input/output equipment (communications, racks, power supplies, and individual I/O modules).
Peripheral and display devices.
All communications networks.

Peripheral devices requiring diagnostic test software shall include the following:

Mass memories (disks, tapes, etc.).
Multiplexing system.
Printers.

"Watchdog" diagnostics shall be provided which periodically check the operation of all communications network nodes and alarm detected problems. Time synchronization between all nodes shall be periodically checked and set by the DCS to prevent inaccurate timing of alarms or SOEs.

2-2.13. DCS Specific Documentation.

2-2.13.01. Program Storage. All operating system and applications software shall be provided with the system on CD-ROM. SUPPLIER shall provide clean (no patches) source files of all programs. Two complete sets of system loadable files and application loadable and source files shall be furnished to the OWNER. The CD-ROMs shall be delivered to jobsite separately from the system hardware.

2-2.13.02. Hardware Maintenance. Sufficient documentation shall be provided to assure efficient maintenance of all SUPPLIER-furnished hardware by OWNER personnel. This documentation shall include point-to-point wiring diagrams and schematic diagrams of all electronic assemblies, supplemented with concise descriptions of the theory of operation of individual subsystems, including third party hardware.

SUPPLIER shall furnish documentation which will assist OWNER personnel in assuring a short mean-time-to-repair in the event of a failure. This may be accomplished by documenting problem symptoms along with possible repair solutions.

Full procedures associated with on-line and off-line diagnostics shall be provided as part of the system. The procedures shall be complete enough to allow maintenance of the equipment to the card level.

2-2.13.03. Programming Reference. Documentation shall be supplied to assist OWNER personnel in software development and maintenance. This documentation shall include descriptions of all programming languages, editors, and utilities supported by the DCS.

Programming documentation shall be included on two levels. One level will be used for training personnel who have a programming background but are unfamiliar with the programming language; the other level shall be used for reference by personnel who are familiar with the language but need concise in-depth information for assistance.

2-2.13.04. System Troubleshooting Guide. Documentation shall be supplied to assist OWNER personnel in analyzing system failures. Documentation shall include but not

be limited to procedures to be followed upon a system failure to isolate the error, locations of pertinent operating system parameters for automatic restarts, and a list of errors that cause system failure.

A troubleshooting guide for software as well as hardware will assist OWNER personnel to locate problems on a malfunctioning system.

2-2.13.05. Control Program Documentation. SUPPLIER shall provide hard copy printouts of all control programs in the system's standard (machine output) documentation format. The number of copies provided shall be as specified elsewhere for all required drawings. SUPPLIER shall document all Modulating Control programs with functional logic diagrams conforming to the format defined in ISA (SAMA) Standard RC22-11 "Functional Diagramming of Instrument and Control Systems," and/or with written descriptions as specified in Section 17500. SUPPLIER shall document all sequential and digital control programs (motor control, valve control, burner control, etc.) with diagrams conforming to one of the formats defined in IEC Standard 1131-3, and/or with written descriptions as required by Section 17500.

2-2.14. System Testing. Testing is described under Section 17500.

2-2.15. Packaging for Shipment. Prior to shipment, all shipping stops, bolts, ties, etc., shall be installed in cabinets and devices. SUPPLIER shall install additional protection as required to prevent damage during shipping. Any delicate modules or circuit boards shall be disconnected, packed, and shipped to the jobsite to be remounted. All accessories, mounting devices, and packing lists shall be packed and shipped with the equipment.

Each separately shipped group of equipment shall be prepared as an individual shipping unit and shall be braced adequately and rigidly so that no damage will occur in transit, lifting, or installation. Provisions shall be made for lifting and skidding. All lifting points shall be clearly marked. Disconnected wiring shall be properly supported. The equipment shall be adequately protected against the weather and mechanical damage during transit and storage.

2-2.16. Training. Training is detailed under 17500.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. DCS installation requirements are specified in Section 17500 except as described herein. Field check, testing, and training shall be as specified in Section 17500.

3-2. CONFIGURATION.

3-2.01. DCS Programming and Configuration. Configuration services are specified in Section 17500.

3-2.02. Communications Configuration. The communications shall be fully configured and installed by CONTRACTOR and shall be operational before application software configuration by others. Communications shall be configured as shown on the block diagram drawing.

3-3. FIBER OPTIC CABLE INSTALLATION AND TESTING. Fiber optic cabling is detailed under 17591.

END OF SECTION

Section 17550

SOFTWARE CONTROL BLOCK DESCRIPTIONS

PART 1 - GENERAL

1-1. SCOPE. This section provides functional descriptions of the PLC and computer software requirements for the Instrumentation and Control System as indicated on the Drawings and referenced in Sections noted below. These descriptions are intended to provide an overview of the operating concept of the plant process equipment rather than describing in detail every operating feature or interlock.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all systems described in this section.

Section 17500 Instrumentation & Control System (PCS)
Section 17532 Distributed Control System (DCS)
Section 17530 Programmable Logic Controllers (PLC)
Section 11272 Chemical Feed System
Section 11320 Grit Removal System
Section 11330 Coarse Screen

PART 2 – PRODUCTS

2-1. GENERAL. The descriptions are applicable to the software specified in the Programmable Logic Controller section.

PART 3 - EXECUTION

3-1. PLC PROGRAMMING FUNCTIONAL REQUIREMENTS. The following paragraphs describe general configuration tasks that are required for the system PLC(s). These tasks shall be programmed in any applicable PLC. Each PLC may have multiple instances of each of these tasks, or may have no instances of some or all of these tasks. The input/output lists (located in these documents as specified in the Instrumentation and Control System section) and detailed equipment control descriptions (included herein) shall be referenced to determine the requirements for each PLC.

The following paragraphs cover functional requirements of the software, which are generic and may or may not be related to any specific control loop.

3-1.01. Available Process Values. All PLC-generated process alarm, equipment status, and process variable values shall be available at any operator workstation.

3-1.02. Flow Values. Flow values shall be integrated, totalized, and stored in the PLC registers so the values displayed on the local PLC Human Machine Interface (HMI), DCS HMI computers and on the field processor will be identical.

3-1.03. System Failure. Failure of a PLC shall result in safe shutdown of associated process equipment. Interposing relays shall be provided where required to assure that equipment will revert to its fail-safe condition. Failure of any PLC or its communication shall be alarmed on the HMI computer.

3-1.04. HMI Computers. The HMI computers (local PLC panel and DCS system) shall function as a monitoring system, not as a controller, for the process equipment. The computer shall download set points and other information to the PLCs, and the PLCs shall perform all control algorithms, so a temporary failure of the any HMI computer will not disrupt plant control.

3-1.05. Rack/Module Configuration. The rack and module definitions for each PLC, as well as the PLC communications configuration shall be completely configured to allow proper addressing of all field connected I/O points. This shall include configuration of any remote input/output (RIO) racks.

3-1.06. PLC Database Definition. Each PLC database will include both field I/O points and internally generated points required for programming. All field I/O points and internal programming points shall be fully defined according to database naming conventions approved by Owner. As a minimum, each database point shall be provided with a tag name, engineering unit, alarm parameters, and description.

3-1.07. Analog Scaling. Each analog input and output will be appropriately scaled for use in internal PLC programming, monitoring by the HMI computers, or transmission to other PLCs. Requirements for raw count values shall be coordinated with the operator interface software to ensure compatibility.

3-1.08. Equipment Runtimes. For each equipment item whose "run" status is monitored by a PLC, an internal equipment runtime shall be accumulated by the respective PLC. The runtime procedure will monitor the status of the equipment "run" contact and, when the equipment is running, increment a software timer that maintains equipment runtime to within a one-minute resolution. The timer shall stop incrementing, but not reset, when the "run" contact indicates that the equipment is not running. The timer value shall increment a counter that maintains an integer value representing the equipment run time in 0.1 hours. The counter value shall be available for display on the HMI computer. A manual reset of the runtime value shall be available at the HMI computers for personnel at the supervisor level and above.

3-1.09. Change-of-State Alarms. While equipment is controllable from the PLC ("in remote"), discrete output commands shall be compared to their respective process feedback status signal (where available) to verify proper execution. If the feedback status does not match the most recent output command (after an adjustable 2 to 300 second time delay), an alarm message shall be displayed on the HMI computer and the condition shall be logged as an alarm, requiring operator acknowledgment. The alarm shall remain energized until the proper discrete condition is sensed or until the operator resets the alarm through the HMI computer.

3-1.10. Equipment Availability. In general, equipment with PLC control has been provided with a local selector switch that transfers control to the PLC. The PLC shall monitor the position of this switch to determine if the equipment is available for PLC control. If the equipment is not available, the PLC program shall not attempt to implement remote manual or automatic status changes for the equipment. The PLC program may, however, need to implement special routines if equipment unavailability affects a sequence (as described in the detailed equipment descriptions).

3-1.11. Maintained/Momentary Outputs. The need for maintained or momentary control outputs shall be determined from the input/output listing and the electrical schematics. In general, equipment with only one control output indicated in the I/O list shall be programmed for a maintained control output. Equipment with two (or more) control outputs shall be programmed for momentary outputs. Provisions shall be made, in either case, to remove the active state (start, open, forward, initiate, etc.) control output when an equipment failure is sensed or when the equipment transitions from available to unavailable (local switch change).

3-1.12. Equipment Mode Changes. Unless otherwise indicated in the equipment control descriptions, equipment in automatic mode shall be transitioned to manual mode (and stopped) if the equipment fails or becomes unavailable or if the PLC processor resets.

3-1.13. Manual/Auto Bumpless Transfer. Unless otherwise indicated in the equipment control descriptions, equipment changes from automatic to manual control shall be bumpless. Equipment running or stopped in automatic mode shall remain running or stopped when manual mode is selected.

3-2. HMI FUNCTIONAL REQUIREMENTS. The following paragraphs describe general configuration tasks that are required for the HMI and related software.

3-2.01. Database. The system database, including field I/O and internal points shall be established according to the database point naming conventions approved by Owner. Database generation for field I/O shall include all required coordination with PLC level addresses. If no Owner database point naming conventions are available, the database

names shall utilize an ISA or ISA-like tag name.

In the default scheme, the format of the tag name is XXX-YYY-ZA.

XXX is the ISA function designation.

YYY-ZA is the unique loop designation defined by the P&IDs.

Where possible YYY-ZA will correspond to the loop numbers on the P&IDs. Otherwise, a unique number shall be assigned. Z is a number (1, 2, 3) to designate similar loops associated with trains of equipment. A is a letter (A, B, C) to designate identical functions within the same loop. For instance, if there are two ferric sulfate metering pumps and the loop number chosen is 222, the remote status input for pump number one might be HS-222-1 and the remote status input for pump number two might be HS-222-2. If there is more than one switch input for either pump the tag name would be HS-222-1A and the second switch would be HS-222-1B.

Function designations currently defined are listed below:

AI's (Analog Inputs)

AIT - Analytical Input	PDIT - Differential Pressure Input (Headloss)
EIT - Voltage Input	PIT - Pressure Input
EIIT - VAR Input	ST - Speed or Rate Input
FIT - Flow Input	TIT- Temperature Input
IIT - Current Input	WIT - Weight Input
JIT - Power Input	ZT - Position Input
LIT - Level Input	

AO's

AC - Residual Proportioning Control	SC - Speed or Rate Control
FC - Flow Proportioning Control	ZC - Position Control

DI's

AAH - Analytical Alarm High	PDSH - High Differential Status
AAL - Analytical Alarm Low	PS - Pressure Alarm Hi/Lo or Unspecified

FSH - High Flow Status
FSL - Low Flow Status
HS - Hand Switch Status
JA - Electrical Alarm
LSH - High Level Status
LSHH - High Water Cutoff Alarm
LSL - Low Level Status
LSLL - Low Water Cutoff Alarm
PSL - Low Pressure Status
PSLL - Low Pressure Cutoff Alarm
WAL - Low Weight Alarm
XA - General or Unspecified Alarm
YA - Equipment Overload Alarm (Failure)
YS - Equipment Run Status
ZSC - Position Closed Status
ZSO - Position Open Status

DO's

LC - PLC Generated LWCO Output
XC - General Control Output
YC - Equipment Start/Stop Command
ZCC - Equipment Close Command
ZCO - Equipment Open Command

Initially, expansion of the existing ICWRC DCS database shall be configured so all database points are defined as belonging to a specific area (as allowed by the graphical interface software). The areas designated for the facility shall be coordinated with Owner. If Owner has no existing standards for area designations, all points can be placed in appropriate areas selected by System Supplier.

3-2.02. Trend Displays. Trend displays shall be developed to present real-time and historical process data in an X-Y graph format. Real-time trends shall utilize current process values to generate temporary graphs that do not retain data values. Historical trends shall utilize historically collected data and shall access the data files directly for use in the trend display. Historical trends shall allow paging forward and back to the limits of the collected data. The trending package shall be configured to automatically retrieve historical data from the proper data file to accommodate the paging functions. Content of the trends will be determined after meeting with Owner. Real-time trend displays and historical trend displays shall be provided for all analog points including calculated values, set-points, and process outputs to continuous variable field devices.

At a minimum, a real-time and historical trend shall be created for each process control loop including the Process Variable(s) (PV), Set-Point (SP), and loop output (OUT). A process control loop real-time trend display shall also include a bar graph display which mimic the display of a field loop controller while providing display and access to the process loop's control parameters (Set-Point, Proportional Gain, Integral Gain, Derivative Gain, Auto/Manual Status) as well as any timing or computational parameters

associated with the process loop.

3-2.03. Alarms. Complete system alarming shall be configured. This shall include configuration of graphical alarm displays, and configuration of audible alarms through the HMI speakers. All process or system alarms shall appear on an alarm summary screen and the alarm banner of each process graphic. Alarms and events shall be color coded on the alarm summary screen, with initial colors based on Owner conventions or the default colors associated with the graphics package. The colors may be adjusted after meeting with Owner. Alarm prioritizing and area assignments (if any) shall be coordinated with Owner at the first configuration meeting.

For LOW or LOW-LOW analog or discrete alarms which do not apply if associated equipment is not operating, provisions shall be made to prevent/Lock generation of the alarm unless the associated equipment is operating. This shall include alarms such as low amperage alarms for pumps that are not running. This may also include low flows or pressures when associated pumps are not operating (this will only apply if periodic operation of the equipment is considered normal).

All alarms/events shall be time stamped when displayed or printed. Unacknowledged alarms shall not automatically clear from the alarm summary if they return to normal before being acknowledged.

3-2.04. Reporting. System reporting shall be accomplished using the standard operator interface software-reporting package provided with the OWNER existing PCS. All necessary report development, including macro development in spreadsheets, shall be supplied to access real-time and historical data for reporting.

3-2.05. Historical Data Collection. System data shall be collected for historical archiving and for use in trending and reporting functions. Requirements for data collection shall be as needed to support the trends and reports developed.

3-2.06. Manual Entry of Data. The human machine interface (HMI) computers shall allow manual entry of laboratory data and other variables, which shall then be available for display and use in reports. Operator entered commands from any of the HMI computers shall be logged at all HMI computers.

3-3. EQUIPMENT CONTROL AND CONTROL MODE OVERVIEW. The following paragraphs explain the general format and control modes that are used in the detailed equipment descriptions. These paragraphs apply to the attached, project specific, equipment control descriptions included herein.

3-3.01. General. Appended to this section are the equipment control programming requirements, with requirements for both PLC programming and the minimum operator interface functions. The HMI requirements represent the anticipated display generation

requirements and shall be adjusted if the PLC programming warrants adjustment.

3-3.02. Control Modes. There are two general control modes available for the process equipment: 1) Remote Manual, and 2) Remote Auto. Remote Manual control provides a means for operators to adjust equipment status or set-point, through the HMI, using manually initiated commands. Remote Automatic control provides a means for automatically changing equipment status or set-point based on measured process parameters, calculated values, or operator set-points. Some equipment may have more than one remote auto mode.

Descriptions for local control are included in the detailed equipment control descriptions. They are provided primarily for documentation purposes and for information. These controls are hardwired and require no programming effort.

3-4. DETAILED EQUIPMENT CONTROL DESCRIPTIONS. The following paragraphs describe specific function requirements for various software control blocks in the control system in 'Remote Auto Mode'. These descriptions are intended to provide an overview of the operational concept for the facilities, rather than describing in detail every operating feature or interlock.

3-4.01 ICWRC Headworks Influent Channels (Ref: Drawing IH001)

The operator directs ICWRC influent flow to Course Screen No. 1 by opening the influent gate (GSC-01) or influent flow to Course Screen No. 2 by opening influent gate (GSC-02).

3-4.02. ICWRC Headworks Coarse Screens No. 1, No. 2 (Ref. Drawings IH001, IH002, IH003)

The operator directs ICWRC influent flow to Course Screen No. 1 by opening the influent gate (GSC-01) or influent flow to Course Screen No. 2 by opening influent gate (GSC-02).

Each Coarse Screen is a single packaged equipment system provided under section 11330. Automatic operation of the process equipment is described under equipment section 11330 as noted below:

Coarse Screen: In Remote Auto Mode the screen shall be controlled by the water level sensors. Screen operation shall be started when the water level sensors monitor a certain water level differential, when the ultrasonic level sensor detects high water level, or when a certain time has passed since the last operation of the screen. Screen operation shall be stopped with an adjustable delay time after the water differential is below a certain value and after the ultrasonic level sensors cease to indicate high water alarm, or after a certain run time has expired (if operation was started by timer).

If the screen rakes experience a jam, the force will cause the rocker arm described above to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to enter a self-clearing mode. The self-clearing mode with attempt to reverse the direction of travel of the rakes for a set period before resuming forward operation. This cycle will be attempted up to three (3) times; if the self-clearing mode should prove unsuccessful then the system shall initiate an alarm signal.

Reset is manually performed after correction of any cause for a trip-out.

With LOR in 'LOCAL' position the operator shall be able to run the rake assembly selecting the respective FORWARD or REVERSE direction from the FORWARD-OFF-REVERSE selector switch.

The Course Screen system provides a relay output to start and run the discharge belt conveyor whenever the Course screen is operating. An operator adjustable time delay will stop the downstream conveyor after the course screen operation is complete to allow the discharge belt conveyor to clear.

A gate 'Open' signal is provided by Transfer Pump Station gate (GSC-11, GSC-21) to the course screen system indicating the discharge gate is in the 'Open' position. An alarm is annunciated when Course Screen operation is required and gate is not in 'Open' position.

All process parameters, operator control selection functions, equipment status, and alarm monitoring functions are displayed on local equipment system panel PLC Operator Interface Terminal (OIT) and duplicated on Plant Control System DCS Human Machine Interface.

3-4.03. ICWRC EQ Tanks (Ref. IF003)

EQ Tank Level is measured by redundant level transmitters. EQ Tank No. 1 level is measured by LE/LIT-10-2 and LE/LIT-10-2. EQ Tank No. 2 level is measured by LE/LIT-10-3 and LE/LIT-10-4. An alarm is annunciated when a level deviation greater than an operator adjustable threshold is detected. The operator may select EQ Tank level measurement from any of the following:

1. Level Transmitter A
2. Level Transmitter B
3. Average of Transmitter A & B
4. Highest Level

ICWRC EQ Tank flow into each tank is controlled by an associated tank motor operated inlet valve (EQ Tank No. 1 inlet valve VPL-70 and EQ. Tank No. 2 inlet valve VPL-101).

Operator selection designates an EQ Tank as 'In Service' when the associated EQ Tank inlet valve is 'Open' and EQ Tank level is below an operable adjustable Hi limit set point.

3-4.04. ICWRC Transfer Pump Station (Ref. Drawings IP001, IP002)

ICWRC Transfer Pump Station consists of six (6) variable speed controlled electric motor operated submersible pumps. Three pumps (Transfer Pump No.1, No. 2, and No. 3) are dedicated for pumping to SRWRC. Two pumps (Transfer Pump No. 5 and No. 6) are dedicated for pumping to EQ Tanks No. 1 and No. 2. Transfer Pump No. 4 may be selected using manually operated valves to pump to SRWRC or the EQ Tanks.

The 'Open' position of each submersible pump's discharge check valve is monitored to confirm individual pump discharge flow and alarm when pump is running without opening of discharge check valve. A High Discharge Pressure switch monitors each submersible pump discharge for alarm and shutdown.

The transfer pump station wet well level is measured by an ultrasonic level transmitter (LE/LIT-30). Transfer pump station wet well Low Level is measured by LSL-32 and interlocked to each Transfer Pump Station VFD to disable pump operation on Low Wet Well Level. Transfer pump station Wet Well High Level is measured by LSH-31 and alarmed on high level.

An operator adjustable Transfer Pump Station Wet Well Level Operating 'set point', Wet Well Maximum Level 'set point', and Wet Well Minimum Level 'set point' establish the 'baseline' for calculating percentage adjustments to the SRWRC Transfer Pump discharge CAS SP, ICWRC EQ Tank Transfer Pump discharge CAS SP, and ICWRC EQ Tank return flow to wet well CAS SP values.

3-4.04.1. SRWRC Transfer Pumps (Ref. Drawing IP001)

SRWRC Transfer pumps in 'Remote Auto' Cascade (CAS) mode are controlled to maintain an operator adjustable (SRWRC Transfer Pump maximum discharge pressure setpoint limited) flow setpoint to SRWRC. Transfer Pump discharge flow to SRWRC is measured by flowmeter FE/FIT-20 (IP001). SRWRC Transfer Pump discharge pressure is measured by PE/PIT-20.

The SRWRC CAS SP is adjusted proportionally downward based on level differential below the 'baseline' Wet Well Operating Level and Wet Well Minimum Level set points for condition where no EQ Tank Transfer Pumps are pumping excess ICWRC influent to EQ Tanks.

Under conditions where the maximum number of EQ Tank transfer pumps are operating (at maximum speed) or the EQ tanks are full (no additional storage ICWRC EQ Tank capacity remains) the SRWRC CAS SP will adjust proportionally upward (increasing SRWRC target flow) based on transfer station wet well level above the 'baseline' operating level set point. As the SRWRC discharge pressure measured by PE/PIT-20 approaches the maximum SRWRC discharge pressure limit the rate of change in the SRWRF CAS SP will be decreased until no further flow rate CAS SP increases are allowed. An alarm shall be generated for this operating condition to notify SRWRC of higher (than normal) flows from ICWRC and / or SRWRC discharge pressure limits are reached.

A low transfer station wet well shutdown level 'set point' will stop all operating SRWRC Transfer Pumps.

The speed of the SRWRC Transfer pumps is controlled through a Proportional-Integral-Derivative (PID) control strategy. The SRWRC transfer pump discharge flow measured by FE/FIT-20 acts as PID Process Variable (PV), wet well level adjusted and SRWRC discharge pressure limited SRWRC discharge target flow acts as PID CAS SP. An operator may select CAS Mode (PID CAS SP), place the PID into 'AUTO' and enter a desired flow (PID AUTO SP), or place the PID into 'Manual Mode'.

The PID output (OUT) varies the speed of the SRWRC Transfer Pumps (each controlled by a Variable Frequency Drive). In PID 'Manual' Mode, the operator may directly adjust the PID output speed to all (running) transfer pumps operating in 'Remote Auto' mode. Each pump placed 'In Remote Manual' may be started and stopped with independent operator control of that pump's speed. The PID output is constrained when the SRWRC high pressure limit is reached and PID output will incrementally lower until SRWRC Transfer Pump Discharge pressure falls below the SRWRC Transfer Pump high discharge pressure setpoint limit.

The wet well level compensated calculated discharge flow PID CAS SP (or PID AUTO SP) is divided by the nominal maximum (per pump) SRWRC Transfer Pump capacity (operator adjustable) to determine the quantity of SRWRC Transfer pumps 'Requested To Run'. When the PID output is below an operator adjustable threshold for an adjustable time (indicative of pumps running at minimum speed), the number of pumps 'Requested to Run' shall decrement to allow remaining pumps to operate at a higher operating speed.

An operator adjustable selection matrix allows SRWRC Transfer Pumps to be placed 'In Service' and selected to 'sequentially stage' as 'Lead', 'Lag1', 'Lag2', (and 'Lag3' when Pump No. 4 is selected and 4 pumps are 'available' for SRWRC Transfer).

The total quantity of SRWRC Transfer Pumps 'In Service' (available to run), quantity of

pumps (actually) running, quantity of pumps 'Requested to Run', and 'Pumps Commanded to Run' values are continuously displayed to operator.

Should an 'In Service' SRWRC Transfer Pump be taken 'Out of Service' through any equipment alarm or manual operator intervention, the Transfer Pump Selection matrix shall automatically adjust quantity of SRWRC Transfer Pumps remaining 'In Service' and eliminate gaps between 'Lead' and any successive 'Lag' pump(s) from remaining 'In Service' Pumps.

When the number of pumps calculated as 'Requested to Run' differs from 'Pumps Commanded to Run' value, the control strategy will increment /decrement the 'Pumps Commanded to Run' count to start (or stop) additional transfer pump(s) (with an adjustable time delay between each successive pump start/stop commands) until the 'Requested to Run' calculation matches the 'Pumps Commanded to Run' quantity of running transfer pumps and number of pumps 'actually' running. SRWRC 'Requested to Run' calculation is inhibited from incrementing where SRWRC flow through FE/FIT-20 exceeds the operator adjustable SRWRC target flow setpoint or SRWRC discharge pressure equals or exceeds SRWRC maximum discharge pressure setpoint. A power failure under Power Recovery Mode 1 (or taking all pumps 'Out of Service') will reset the 'Commanded to Run' counter to zero. The SRWRC 'Requested to Run' value cannot exceed the number of 'In Service' pumps (available to run).

The HMI shall allow for operator overwrite (manual adjustment) of the 'Pumps Commanded to Run' value to bypass time delays between start / stop cycles. The maximum quantity of 'Requested To Run' and 'Pumps Commanded to Run' shall be adjusted in logic not to exceed the maximum number of 'In Service' pumps.

A system alarm shall be generated for conditions whereby the calculated quantity of 'Requested To Run' pumps exceed the quantity of 'In Service' pumps.

Operator selection shall determine transfer pump power failure recovery mode. Power Recovery Mode 1 shall reset all counters and the system will resume pumping operations from a 'quiescent' state (no pumps initially running) upon power restoration. Power Recovery Mode 2 shall restore quantity of pumps (initially) running as existed prior to power failure.

3-4.04.2. <u>ICWRC EQ Tank Transfer Pumps</u> (Ref. IP001, IP002, IF003)

ICWRC EQ Tank Transfer pumps in 'Remote Auto' Cascade (CAS) mode are flow controlled with high EG Tank discharge pressure limiting as measured by PE/PIT-10 (Ref. IF003) based the positive difference between the ICWRC influent flow and SRWRC transfer pump discharge flow (FE/FIT-20, IP001) adjusted for Transfer Pump Station Level above (or below) the baseline level 'set point' in the Transfer Pump Station wet well (LE/LIT-30), and selection of one (or more) ICWRC EQ Tanks (Ref.

IF003) with available capacity for interim storage at ICWRC.

The EQ Tank Transfer Pump Flow CAS SP is calculated as ICWRC Influent flow subtracting FE/FIT-20, Ref. IP001) flow (+/- wet well level compensation) updated whenever ICWRC influent flow exceeds the SRWRC Transfer Pump discharge flow (FE/FIT-20, IP002) for an operator adjustable period of time and at least one EQ Tank is 'In Service' with capacity available to accept flow from the ICWRC EQ Tank Transfer Pumps.

When ICWRC Influent flow drops below SRWRC Transfer Pump Station discharge flow for an operator adjustable period of time, the ICWRC EQ Tank Transfer Pump Flow CAS SP will return to a value of 'zero' initiating a sequential stopping of all running EQ Tank Transfer Pumps.

The ICWRC EQ Tank Transfer Pump Flow CAS SP is adjusted proportionally higher (or lower) based on level differential above (or below) the 'baseline' Wet Well Operating Level and Wet Well Maximum (or Minimum) Level set points.

A Transfer Station Wet Well low level shutdown level 'set point' will stop all operating EQ Tank Transfer Pumps. When available EQ Tank capacity has been exhausted, all operating EQ Tank Transfer pumps will stop.

The speed of the EQ Tank Transfer pumps is controlled through a Proportional-Integral-Derivative (PID) control strategy. The EQ Tank transfer pump discharge flow measured by FE/FIT-10 (IF003) acts as PID Process Variable (PV), level compensated ICWRC Influent flow less SRWRC discharge flow (FE/FIT-20) acts as PID CAS SP. An operator may select CAS Mode (PID CAS SP), place the PID into 'AUTO' and enter a desired flow (PID AUTO SP), or place the PID into 'Manual Mode'.

The PID output (OUT) varies the speed of the EQ Tank Transfer Pumps (each controlled by a Variable Frequency Drive). In PID 'Manual' Mode, the operator may directly adjust the PID output speed to all (running) transfer pumps operating in 'Remote Auto' mode. Each pump placed 'In Remote Manual' may be started and stopped with independent operator control of that pump's speed.

The PID output is constrained when the EQ Tank Transfer Pump Discharge high pressure limit is reached and PID output will incrementally lower periodically until EQ Tank Transfer Pump Discharge pressure falls below the EQ Tank Transfer Pump high discharge pressure setpoint limit.

The calculated wet well level compensated and discharge pressure limited EQ Transfer flow PID CAS SP (or PID AUTO SP) is divided by the nominal maximum (per pump) ICWRC EQ Tank Transfer Pump capacity (operator adjustable) to determine the quantity of ICWRC EQ Tank Transfer pumps 'Requested To Run'. When the PID

output is below an operator adjustable threshold for an adjustable time (indicative of pumps running at minimum speed, the number of pumps 'Requested to Run' shall decrement to allow remaining pumps to operate at a higher operating speed.

An operator adjustable selection matrix allows ICWRC EQ Tank Transfer Pumps to be placed 'In Service' and selected to 'stage' as 'Lead', 'Lag1', (and 'Lag3' when Pump No. 4 is selected and 3 pumps are 'available' for EQ Tank Transfer).

The total quantity of ICWRC EQ Tank Transfer Pumps 'In Service' (available to run), quantity of pumps (actually) running, quantity of pumps 'Requested to Run', and 'Pumps Commanded to Run' values are continuously displayed to operator.

Should an 'In Service' ICWRC EQ Tank Transfer Pump be placed 'Out of Service' through any equipment alarm or manual operator intervention, the Transfer Pump Selection matrix shall automatically adjust quantity of EQ Tank Transfer Pumps remaining 'In Service' and eliminate gaps between 'Lead' and any successive 'Lag' pump(s).

When the number of pumps calculated as 'Requested to Run' differs from 'Pumps Commanded to Run' value, the control strategy will increment /decrement the 'Pumps Commanded to Run' count to start (or stop) additional transfer pump(s) (with an adjustable time delay between each successive pump start/stop commands) until the 'Requested to Run' calculation matches the 'Pumps Commanded to Run' quantity of running transfer pumps and number of pumps 'actually' running. EQ Tank Transfer Pump 'Requested to Run' calculation is inhibited from incrementing where SRWRC flow through FE/FIT-20 is below (within an adjustable deadband) of the operator adjustable SRWRC transfer pump target flow set point unless wet well level is above the wet well level target operating set point.

EQ Tank Transfer Pump 'Requested to Run' calculation is inhibited from adding another pump where EQ Tank Transfer Pump Discharge Pressure exceeds the High Discharge Pressure limit setpoint.

A power failure under Power Recovery Mode 1 (or taking all pumps 'Out of Service') will reset the 'Commanded to Run' counter to zero. The EQ Tank Transfer Pump 'Requested to Run' value cannot exceed the number of 'In Service' pumps (available to run).

The HMI shall allow for operator overwrite (manual adjustment) of the 'Pumps Commanded to Run' value to bypass time delays between start / stop cycles. The maximum quantity of 'Requested To Run' and 'Pumps Commanded to Run' shall be adjusted in logic not to exceed the maximum number of 'In Service' pumps.

A system alarm shall be generated for conditions whereby the calculated quantity of

'Requested To Run' pumps exceed the quantity of 'In Service' pumps.

Operator selection shall determine transfer pump power failure recovery mode. Power Recovery Mode 1 shall reset all counters and the system will resume pumping operations from a 'quiescent' state (no pumps initially running) upon power restoration. Power Recovery Mode 2 shall restore quantity of pumps (initially) running as existed prior to power failure.

EQ Tank Transfer pumps are interlocked to Run only upon selection of (at least) one ICWRC EQ Tank as 'In Service' (Ref. IF003).

3-4.04.3. ICWRC EQ Tank Selection (Ref. IF003, IP001, IP002)

The operator shall be provided with capability to enable 'Parallel' or 'Sequential' operation of EQ Tanks (Ref. IF003) for either tank filling or tank discharge operations. Where parallel operation is desired, both 'In Service' EQ Tanks shall open (or close) associated Motor-operated valve(s) to allow (or inhibit) EQ Tank Transfer Pump operations or EQ Tank discharge flow. Where 'Sequential' Tank Filling (or Discharge) operations are desired, Tanks shall be sequenced based on a First In, First Out basis. Operator shall be able to select the order of tanks for sequential filling or sequential tank discharge.

3-4.04.4. ICWRC EQ Tank Return Flow to Transfer Pump Station Wet Well (Ref. IF003, IP001, IP002)

When ICWRC Influent flow drops below SRWRC Transfer Pump discharge flow (FE/FIT-20, IP002) for an operator adjustable period of time and all EQ Tank Transfer Pumps have stopped (no longer transferring flow to EQ Tanks), operator selected EQ Tank(s) discharge MOV (EQ Tank No. 1 discharge valve VPL-100, EQ Tank No. 2 discharge valve VPL-102) is opened to return flow from 'In Service' EQ Tank(s) to Transfer Station wet well.

EQ Tank Transfer Pumps are interlocked as not to operate while EQ Tanks are returning flow back to the transfer pump station wet well.

Whenever EQ Tank(s) are empty, or whenever the calculation indicates at least one EQ Tank Transfer Pump is 'Requested to Run' and available EQ tank capacity exist for EQ Tank Transfer pump operation, the EQ Tank discharge valve(s) close and EQ Tank Transfer Pump operation is enabled.

3-4.05. ICWRC Transfer Pump Station Flow to SRWRC Primary Clarifier Influent Diversion Box (Ref. IB005, IB001)

Flow from ICWRC Transfer Pump Station to SRWRC is measured by flowmeter FE/FIT-

30. Flow can be manually diverted to the Clarifier Influent Junction Box or to a bypass line to the Tunnel Pump Station.

3-4.06. SRWRC Preliminary Treatment Building to Clarifier Influent Junction Box Flows (Ref. IB005, IB001)

Flows from SRWRC Preliminary Treatment Building to Clarifier Influent Junction Box is measured by FE/FIT-40 and FE/FIT-50.

3-4.07. SRWRC Ferric Chloride Storage and Chemical Feed (Ref. IC007, IC009)

Ferric Chloride is stored in two existing bulk storage tanks. Bulk storage tank levels (FECL-LE/LIT-100 and FECL-LE/LIT-200) are measured and alarmed.

Three (3) Ferric Chloride Metering Pumps (FECL-PPS-100, FECL-PPS-200, and common spare FECL-PPS-300) provide metered chemical injection to two injection points (SRWRC Primary Clarifiers Junction Box / 'Emergency' to Filter Influent and SRWRC Final Clarifiers).

In Remote Auto Mode, the primary (or selected common backup) pump will vary chemical feed to SRWRC Primary Clarifiers Junction Box or 'Emergency' to Filter Influent based on based on an operator manually entered setpoint.

Metering pump discharge flow is measured and totalized. Metering pump operation is monitored for metering pump running status, pump 'In Remote' status, pump failure, and high pump discharge pressure alarm (with associated time delay interlocked to pump operation).

3-4.08. SRWRC Head House Influent Channels (Ref. IB001)

Motor actuated gates (GSD-10, GSD-20, GSD-30, GSD-40) is operator controlled to select SRWRC influent flow into each of four (4) downstream Primary Clarifiers. An operator command to open a Primary Clarifier Influent Gate places the Primary Clarifier 'In Service'. An alarm is annunciated if the Primary Clarifier influent gate is 'Open' and the Primary Clarifier is not running.

Primary Clarifier Influent Gate Open / Closed positions, Gate Motor Operator Local – Off- Remote Status, and Motor Operator Fault Status is monitored and alarmed. Clarifier Influent High Level (LSH 10) is monitored and alarmed.

Clarifier Influent Junction Box mixers (MSH-10, -20, -30, -40) are operator controlled to run continuously. Mixer 'In Remote', 'Running', status are monitored and Mixer 'Failure' and 'Moisture Intrusion' alarms are annunciated.

3-4.9. SRWRC Primary Clarifiers (Ref. Drawings IB002, IB003)

(Typical for each of two (2) Primary Clarifiers)

The associated hydraulic clarifier drive is started locally and runs continuously. Operators remotely monitor clarifier rake torque percentage (of full rating). Clarifier rake hydraulic unit is monitored for unit running, unit failure, clarifier rake high torque warning alarm, clarifier rake high torque trip alarm, and clarifier rake hydraulic unit low oil pressure alarm. Clarifier Level is monitored and alarmed.

3-4.10. SRWRC Primary Clarifiers Scum Pumps (Ref. Drawing IB004)

(Typical for each of two (2) Primary Clarifier Scum Pump Systems)

In 'Remote Auto' Mode, the 'Lead' Scum Pump will start upon sensing Scum Well High Level. The 'Lag' Scum Pump will start upon 'High High Level and 'High High' level generates an alarm. All running Scum pumps will operate until Scum well level drops below Low Level. After Scum Pump(s) stop, the 'Lead' pump and 'Lag' Pump will alternate for next pump cycle. Scum Pump Failure, Scum Pump LOR 'In Remote', Scum Pump Motor Hi Temperature, and Scum Pump Moisture Intrusion is monitored and alarmed.

3-4.11. SRWRC Primary Sludge Headhouse Pumps (Ref. Drawings IB002, IB003, IR001, IR002, IR003)

(Typical for each of two (2) Primary Clarifiers)

When a Primary Clarifier is locally started and is running, one of two (2) associated Primary Clarifier Sludge Pumps will start and run based on an operator adjustable "Time On / Time Off' schedule with each Clarifier's Sludge pump interlocked to other Clarifier Sludge Pumps to prevent simultaneous operation.

The associated upstream Grinder (IR001) shall start, after an adjustable time delay the associated downstream Sludge Pump Discharge Valve (VPL-R21, VPL-R22, VPL-R23, VPL-R24) will open and the Sludge Pump shall start and run for the designated time interval. Operators manually adjust the VFD drive speed of the running Sludge Pump based on desired discharge flow measurement from Primary Sludge Pump discharge flow meter (FE/FIT-10R, -20R, -30R, -40R). After the 'Time On interval has expired, the Grinder and Sludge Pump will stop simultaneously with the closing of the sludge pump's discharge valve. Once the discharge valve is confirmed in 'Closed' position, the next sludge pump, grinder, and associated discharge valve whose 'Timed Off' interval has expired will start.

Operator may change selection of operating Sludge Pump by placing Pump into

‘Remote Auto’ or ‘Remote Manual’.

Sludge Pump High discharge pressure, sludge pump failure, sludge pump leak detection, and sludge pump rotation failure conditions are monitored and alarmed.

3-4.12. SRWRC Primary Sludge Head House Clarifier Drain Pumps (Ref. Drawing IR003)

Each Clarifier Drain Pump is manually started and operated by operator command.

Clarifier Drain Pump High discharge pressure, drain pump failure, and drain pump leak detection conditions are monitored and alarmed.

End of Section

Section 17561

PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL.

1-1. SCOPE. The Panel Mounted Instruments section covers the furnishing of all panel mounted instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. For "smart" devices, calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs describe minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01 Programming Device. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training stipulations. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.02 Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows XP operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. PANEL FRONT MOUNTED DEVICES.

2-2.01. Annunciators. Not used

2-2.02. Totalizers. Not used

2-2.03. Digital Panel Indicators. Digital indicators shall be designed for semi-flush mounting in a panel. The indicator shall be a 3-1/2 digit LED, LCD, or gas discharge type display, with digits at least 0.5 inch high. The indicator shall be easily read at a distance of 10 feet in varying control room lighting environments. Operating temperature range shall be 32°F to 140°F. Accuracy shall be ±0.1 percent. The indicator shall be scaled in engineering units, with the units engraved on the display face or on the associated nameplate. The indicator shall have a selectable decimal point and shall provide over-range indication. Digital indicators shall be manufactured by Invensys / Eurotherm / Action Instruments, Newport Electronics, Precision Digital Corporation, or Red Lion Controls.

2-2.04. Electronic Bar Graph Indicators. Not used.

2-2.05. Edgewise Panel Indicators. Not used.

2-2.06. Manual Loading Stations. Not used.

2-2.07. Ratio Stations. Not used.

2-2.08. 1/4 DIN Single-Loop Control Stations. Not used.

2-2.9. 1/4 DIN Manual/Auto Backup Stations. Not used.

2-2.10. Large Case Recorders. Not used.

2-2.11. Strip Chart Recorders. Not used.

2-2.12. Panel-Mounted Pressure Gauges. Gauge sizes and scale ranges for pressure, vacuum, or compound gauges shall be as indicated on the Drawings or the Instrument Device Schedule. Gauges shall be of the differential pressure type where indicated. Gauge scales shall have at least 5 major and 50 minor divisions. Major divisions shall be equally spaced and shall be in whole integers. Scale units (inches, psi, and feet) shall be engraved on the scale face. Each gauge shall be provided with a ball-type shutoff valve.

All gauges with spans of 10 psi or less shall have AISI Type 316 stainless steel bellows and connections. All process gauges with spans greater than 10 psi shall have an AISI Type 316 stainless steel Bourdon tube and connections.

The manufacturer's standard ranges will be considered if approximately equal to the specified range. However, Engineer reserves the right to require special scales and calibration if the manufacturer's standard is not acceptable. Gauges shall have clear acrylic or shatterproof glass windows, adjustable pointers, stainless steel geared movements, and shock-resistant cases. Pointer travel shall span not less than 200 degrees or more than 270 degrees. Gauge accuracy shall be nominal 1 percent of span, corresponding to ANSI B40.1, Accuracy Grade A. Gauges shall be manufactured by Ashcroft, Ametek/U.S. Gauge, or Weksler.

2-2.13. Digital and Panel Clocks. Not used.

2-2.14. Switches, Lights, and Push Buttons.

2-2.14.01. Selector Switches. Selector switches shall be 30.5-mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 V ac. Contact configuration shall be as indicated on the Drawings or for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2-2.14.02. Indicating Lights. Indicating lights shall be 30.5-mm, heavy-duty, oil-tight type, with full voltage LED lamps. Legends shall be engraved on the lens or on a

legend faceplate. Lights shall be push-to-test type. Indicating lights shall be Eaton/Cutler Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2-2.14.03. Push Buttons. Push buttons shall be 30.5-mm, heavy-duty, oil-tight type. Legends shall be engraved on the push-button faceplate. Contacts shall be rated 10 amperes continuous at 120 V ac. Push buttons shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2-2.15. Alarm Horns. Horns shall be high-decibel, panel-mount, vibrating type designed for heavy-duty use. Horn volume shall be field-adjustable from 78 to 103 dB at 10 feet. Horns shall operate at 120 volts ac. Horns shall be weatherproof NEMA Type 4X. Horns shall be panel front mounted or supplied with a field mounted enclosure and shall be supplied with gasket. Panel mounted horns shall be Edwards Signals “870P Series.” Field mounted horns shall be Edwards Signals “876 series.”

2-3. PANEL INTERIOR MOUNTED DEVICES.

2-3.01. Integrators. Not used.

2-3.02. Power Supplies. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or short circuit protected. Output voltage regulation shall be by the instrumentation equipment supplied. Multi-loop or multisystem power supplies will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so either the primary or the backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation. Multi-loop power supply connections shall be individually fused so a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and shall be located for easy access. Multi-loop supply systems shall be oversized for an additional 10 percent future load. Failure of a multi-loop supply shall be indicated on the respective instrument panel or enclosure.

Power supplies shall be Allen Bradley, Phoenix Contact, PULS, or equal.

2-3.03. Relays. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver cadmium oxide contacts rated 10 amperes at 120 V ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low-level signals. Relays used for computer input, alarm input, or indicating light service shall

have contacts rated at least 3 amperes. Time delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of ±2 percent of setting. Latching and special purpose relays shall be for the specific application. Unless otherwise indicated, all relays shall have an integral pilot light that illuminates to indicate an energized condition and push-to-test feature. Relays shall be IDEC "Series RR" or 'RU'; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series 219, 246".

2-3.04. Intrinsically Safe Relays. Relays shall be solid-state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe use in hazardous areas. Relays shall be located in non-hazardous areas. Relays shall be manufactured by GEMS, MTL, R.Stahl, Inc., or Turck.

2-3.05. Electronic Signal Booster/Isolators. Electronic signal boosters and isolators shall have all solid-state circuitry and complete electrical isolation between the power supply and the input and output signals. Accuracy shall be ±0.15 percent of span. Isolators shall be manufactured by Acromag, Moore, Phoenix Contact or R.I.S.

2-3.06. Electronic Signal Selectors. Not used.

2-3.07. Electronic Signal Summers. Not used.

2-3.08. Fixed Deadband Signal Monitors. Not used.

2-3.09. Adjustable Deadband Signal Monitors. Not used.

2-3.10. Strip Heaters. Electric strip heaters shall be provided as indicated on the Drawings, as specified, and for the application. Strip heaters shall be sized to prevent condensation within the enclosure and to maintain the equipment above its minimum operating temperature. Strip heaters shall be located to avoid overheating electronic hardware or producing large temperature fluctuations. Strip heaters shall be controlled by adjustable thermostats with adjustment ranges of 30° to 90°F. A circuit disconnect switch shall be provided within the enclosure.

2-3.11. Intrinsically Safe Barriers. Barriers shall be solid-state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe use in hazardous areas. Barriers shall be located in non-hazardous areas. Barriers shall be manufactured by MTL, R. Stahl, Inc., or Turck.

PART 3 – EXECUTION

3-1 FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section. Instruments shall not be shipped to the Work Site until two weeks prior

to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 17563

PRESSURE AND LEVEL INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of pressure and level instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings or Instrument Device Schedule.

2-1.02. Programming Device. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section.) The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 7 (or later) operating systems. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. PRESSURE INSTRUMENTATION.

2-2.01. Pressure Transmitters. Transmitters shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. Process fluid shall be isolated from the sensing elements by AISI Type 316 stainless steel, Hastelloy-C, ceramic, or cobalt-chromium-nickel alloy diaphragms, and the

transducer may use a silicone oil fluid fill. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0° to 180°F, and relative humidity of 5 to 100 percent. All parts shall be stainless steel unless otherwise noted or required for the application. Transmitters shall have over-range protection to maximum line pressure. Accuracy of the transmitter shall be 0.075 percent of span, and transmitter output shall be 4-20 mA dc without the need for external load adjustment. Transmitters shall not be damaged by reverse polarity. Transmitters shall have an elevated or suppressed zero. For calibrated spans of less than 8 psig a differential pressure type transmitter with side vents shall be utilized. Transmitters shall be provided with stainless steel brackets for wall and pipe-stand mounting.

Where shown on drawings or instrument device schedule, a diaphragm seal shall be provided as detailed under 17563-2.2.18.1.

Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

Transmitters shall be indicating type shall be furnished with LCD type digital indicators.

Transmitters shall be provided with integral surge protection for analog output signal.

Transmitters will have a turndown ratio of 30:1, or more.

Transmitters shall be ABB “Model 264GS”, Endress+Hauser “Cerabar S”, or “Deltabar S Series”, Foxboro "Model IGP10", Rosemount “Model 2051”, or Siemens “SITRANS P.

2-2.02. Premium Accuracy Pressure and Pressure Sensing Level Transmitters. Not used.

2-2.03. Differential Pressure Transmitters. Not used.

2-2.04. Premium Accuracy Differential Pressure Transmitters. Not used.

2-2.05. Flange-Mounted Pressure Sensing Level Transmitters. Not used.

2-2.06. Ultrasonic Level Transmitters. Each ultrasonic level transmitter shall be a microprocessor-based electronic unit consisting of a sensor assembly, a signal converter/transmitter, and an interconnecting cable. The sensor shall be encapsulated in a chemical and corrosion-resistant material such as kynar or CPVC, and shall be suitable for operation over a temperature range of -20° to +150°F [-28° to +66°C] and a relative humidity of 10 to 100 percent. The sensor shall be compatible with the process media being measured. Where indicated on the Drawings or in the Instrument Device

Schedule, the sensor shall be an explosion-proof or intrinsically safe design suitable for use in all hazardous areas. Sensors mounted in areas subject to freezing shall be provided with special transducers or protected against icing by heaters. Sensors mounted in direct sunlight shall be provided with sunshades.

The supplier shall coordinate the sensor mounting requirements and furnish drawings complete with dimensions and elevations. General installation requirements are indicated on the Drawings.

The ultrasonic level transmitter shall have automatic compensation for changes in air temperature at the sensor location. If separate temperature sensing probes are provided, they shall be mounted with or adjacent to the ultrasonic sensor, as recommended by the manufacturer. The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 1/2 inch [12 mm]. The transmitter shall be designed to ignore momentary level spikes, false targets, or momentary loss-of-echo. A loss-of-echo condition shall be indicated on the transmitter unit and shall be available as an alarm contact output. The transmitter output shall be an isolated 4-20 mA dc signal linearly proportional to the measured level range, or where indicated on the Drawings or in the Instrument Device Schedule, shall be characterized to be proportional to the tank volume. Calibration parameters shall be entered through a keypad on the unit and shall be stored in nonvolatile EEPROM memory. Accuracy of the transmitted signal shall be ±0.5 percent of the level range.

Where indicated on the Drawings or in the Instrument Device Schedule, the transmitter shall be a differential level-sensing unit that accepts inputs from two ultrasonic level sensors. The transmitter output shall be proportional to the difference in level. The differential value shall be displayed on the unit. An adjustable alarm contact, actuated by differential level, shall be provided.

The transmitter shall contain four independently adjustable level alarm contact outputs. Contacts shall be single-pole, single-throw, or double pole where indicated in the device schedule, rated not less than 5 amperes at 120 V ac.

A sufficient length of sensor-to-transmitter signal cable shall be furnished with the instrument to locate the sensor 25 to 200 feet [7.6 to 61 m] from the signal converter.

The signal converter electronics shall be housed in a weatherproof, corrosion-resistant NEMA Type 4X enclosure suitable for wall or pipestand mounting and for operating temperatures of -5° to +122°F [-20° to +50°C] and a relative humidity of 10 to 100 percent. A thermostatically controlled strip heater shall be provided in the signal converter enclosure.

The signal converter shall be of the ac-powered type (unless noted otherwise). Transmitters shall be provided with integral surge protection for analog output signal.

The ultrasonic level transmitter shall be Siemens “HydroRanger 200”, Pulsar “Ultra 3”, Endress+Hauser “Prosonic”, or Magnetrol “Echotel 344.”

Sludge blanket level applications shall utilize a Hach Sonatax sc Sludge Blanket Level Probe with Hach SC200 transmitter / controller or approved equal.

2-2.07. Admittance Probe Level Transmitters. Not used.

2-2.08. Submersible Pressure Sensing Level Transmitters. Not used.

2-2.09. Bubbler System Components. Not used.

2-2.10. Fixed-Mount Float Type Level Switches. Not used.

2-2.11. Weighted Float Type Level Switches. Each level switch shall consist of a single-pole, double-throw mercury switch, rated not less than 3 amp [A] ac, sealed and housed in a chemical-resistant polypropylene casing. The switch assembly shall be weighted and suspended on a waterproof, three-conductor, synthetic covered flexible cable with19 AWG [0.5 mm2] conductors and of such length that no splice or junction box is required in the wet well. Switches shall be suitable for operation at up to 150 V ac within an ambient temperature range of 0 to 60°C. Switches shall be suitable for use in a sanitary wastewater wet well. Adjustable mounting hardware shall be provided for supporting each level switch. Switches shall be Ametek B/W Controls "Series 7010", Siemens "LSC", ITT/Flygt "ENM-10", or Gems Sensors & Controls/Warrick Controls "Series M".

Float switches will be provided with intrinsically safe low-energy type relays. Relays are specified under Section 17561, Panel Mounted Instruments. The relays shall be mounted in nonhazardous locations, and the wiring conduit leading into the hazardous area sealed in accordance with NEC Code.

2-2.12. Adjustable Deadband Float Type Level Switches. Not used.

2-2.13. Electrode/Conductance Relay Level Switches. Not used.

2-2.14. Flange-Mounted Displacement Float Type Level Switches. Not used.

2-2.15. Flood Level Switches. The flood detecting level switches shall be float actuated, constructed of non-corroding material compatible with the measured process, and shall be suitable for wall bracket or sump mounting, as indicated on the Drawings or in the Instrument Device Schedule. The switch float mechanism shall actuate when the process measurement level rises to 1 inch [25 mm] above the bottom of the housing. The switch contacts shall be hermetically sealed, rated for 0.1 amp [A] at 120 V ac, and shall be field changeable from normally open to normally closed. Flood switches shall

be Innovative Components “LS-15-605”, Dwyer ‘F7 series", Siemens 101G, or approved equal.

2-2.16. Ultrasonic Level Switches. Not used.

2-2.17. Pressure Switches. Pressure switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches mounted inside panels shall have NEMA Type1 housings. All other switches shall have NEMA 4X housings. Switches shall be differential type where indicated in the Instrument Device Schedule. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or Viton and the connection port shall be stainless steel.

Panel-mounted and surface-mounted switches shall be provided with 1/4 inch [6 mm] NPT connections. All stem-mounted switches shall be provided with 1/2 inch [12 mm] NPT connections.

All pressure switches shall be ranged in psi [kPa] and all vacuum switches in inches [mm] of water. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp [A] at 120 V ac.

Each switch shall be provided with a threaded end, ball-type shutoff valve. Shutoff valve materials shall be compatible with the process fluid. Where the process is not specified, valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals. Multi-port valves shall have all unused ports plugged. Shutoff valve construction shall be as detailed in the Miscellaneous Instruments section.

Where indicated on the Drawings or in the Instrument Device Schedule, the switch shall be provided with a pressure snubber. Each snubber shall be of a size and pressure range compatible with the switch served. Snubbers shall be Ashcroft "Pulsation Dampers", or approved equal.

Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective switch. Diaphragm seal requirements are detailed 13563-2.2.18.1.

Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All

connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal.

Switches shall be manufactured by Ashcroft, Barksdale, Dwyer / Mercoid, ITT / NeoDyn, S.O.R, or United Electric.

2-2.18. Field-Mount Pressure Gauges. Pressure gauges shall be of the indicating dial type, with C-type phosphor bronze Bourdon tube; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

Gauge dial shall be 4-1/2 inch size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees or more than 270 degrees of arc.

Surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections. Where indicated in the Drawings or on the Instrument Device Schedule, stem mounted gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.

All pressure gauges shall measure in psi and all vacuum gauges in inches water. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 0.5 percent of scale range.

Each gauge shall be provided with a threaded end, ball-type gauge valve. Gauge valve materials shall be compatible with the measured process. Where the process is not defined, gauge valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals compatible with the measured process. Multi-port gauge valves shall have all unused ports plugged. Gauge valve construction shall be as detailed in the Miscellaneous Instruments section.

The pressure gauge shall be provided with a pressure snubber. Each snubber shall be of a size and pressure range compatible with the gauge served. Snubbers shall be Ashcroft "Pulsation Dampers", or approved equal.

Gauges shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All gauges, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at gauge locations prior to installation of the gauge or diaphragm seal.

Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or the Instrument Device Schedule.

Unless otherwise indicated, mounting and installation hardware shall be Type 316L stainless steel.

Pressure gauges shall be Ashcroft "1279 Duragauge", U.S. Gauge 1980L, or equal.

2-2.18.1. Diaphragm Seal Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective gauge or instrument. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel (or non-corroding material compatible with measured process) diaphragm, and stainless steel (or non-corroding material compatible with measured process suitable for operating temperatures and pressures) upper and lower housings. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the gauge with the system under pressure. The lower housing shall be provided with a tapped and plugged 1/4 inch NPT flushing connection. Each diaphragm seal and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

Diaphragm seals shall be Ashcroft Type 101, Mansfield and Green Type SG, or approved equal.

2-2.19. Annular Type Pressure Sensors. Pressure sensors shall be of the wafer type, designed to fit between standard class 150 and class 300 pipeline flanges. Flange material shall be the same as the surrounding pipeline. Sensor shall be flow through design with flexible elastomer sensing ring around the full circumference. The elastomer sensing ring shall be rigidly clamped between metal end cover flanges, and no part of the elastomeric sensing ring shall be exposed to the external face of the sensor. There shall be no dead ends or crevices, and flow passage shall make the sensor self-cleaning.
The pressure-sensing ring shall measure pressure for 360° around the full inside circumference of the pipeline. Flexible sensing ring shall have a cavity behind the ring filled with fluid to transfer pressure to the gauge. Sensing ring material shall be compatible with the process. Fill fluid shall be suitable for use with the process temperatures.

Annular pressure sensors shall be OPW Iso-Ring, Red-Valve “Series 48” or equal.

2-2.20. Thermal Dispersion Level Switch Each level switch shall utilize a thermal dispersion type, explosion-proof, and stainless steel or Hastelloy C sensing element (compatible with the process liquid) installed in the process vessel. The insertion length of the element shall be approximately one to two inches inside the vessel, and all

mounting accessories shall be provided. The sensor shall have a 1 inch [25 mm] MNPT mounting connection.

The electronic transmitter shall be locally mounted onto the sensing element assembly or remotely mounted within 30 feet [9.1 m] of the sensor with interconnecting cable provided, as indicated on the Drawings or in the Instrument Device Schedule. The transmitter shall be of the ac-powered type. The unit shall be housed in an explosion-proof enclosure suitable for hazardous locations as required for the application. The transmitter shall have a DPDT relay contact output rated 6 amps at 115vac, 240vac or 24 vdc. The level switch operating range shall be -4 deg. To 350 deg. F with an accuracy of +/- .25 inch and +/- .125 inch repeatability. The level switch shall be Fluid Components Incorporated “FLT93S FlexSwitch Series”; Kurz Instrument “454 Series”, STI Magnetrol “Thermatel TD1 / TD2”; or Sierra Instruments, Inc. “InnovaSwitch”.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 17564

PROCESS GAS ANALYTICAL INSTRUMENTS

PART 1 - GENERAL.

1-1. SCOPE. This section covers the furnishing of all process gas analytical instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or in the Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System Section

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in as specified in the Instrumentation and Control System section.

1-4.01. Cleaning. Instruments indicated to be utilized in oxygen, ozone, or similar service shall be cleaned for oxygen service, labeled appropriately, and bagged or packaged as necessary to ensure the instrument will remain suitable for insertion in the process during installation. Any special mounting or installation requirements associated with such instruments shall be detailed on tags attached to the instrument.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Drawings and/or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 7 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. PROCESS LIQUID ANALYTICAL INSTRUMENTATION.

2-2.01. Low Range Turbidity Analyzers. Not used.

2-2.02. Surface Scatter Turbidity Analyzers. Not used.

2-2.03. pH and ORP Analyzers. Not used.

2-2.04. Dissolved Oxygen Analyzers. Not used.

2-2.05. Streaming Current Analyzers. Not used.

2-2.07. Particle Counters. Not used.

2-2.08. Chlorine Residual Analyzers. Not used.

2-2.08.04. Gas Stripped Chlorine Residual Analyzers. Not used.

2-2.09. Dissolved Ozone Analyzers. Not used.

2-2.10. Nuclear Sludge Density Meters. Not used.

2-2.11. Conductivity Analyzers – Electrode Type. Not used.

2-2.12. Conductivity Analyzers – Electrodeless Type. Not used.

2-3. PROCESS GAS ANALYTICAL INSTRUMENTATION.

2-3.01. Gas Detector Systems. Gas detector systems shall be furnished complete with sensors, power supplies, alarm modules, enclosures, and appurtenant devices suitable for detecting gases as indicated on the Drawings or as listed in this section. Detector systems shall be located as indicated on the Drawings.

Gases to be detected and associated detector sensor ranges and nominal alarm setpoints shall be as follows:

Gas	Nominal Range	Nominal “Warning” and "Alarm" Values
Combustible Gas (methane)	0-100 percent LEL	10 percent/ 50 percent LEL
Hydrogen Sulfide (H_2S)	0-10 ppm or 0-50 ppm	0.5 ppm/1 ppm

Accuracy of each gas detector system shall be 2 percent of full scale, and zero drift shall not exceed 5 percent per year. Gas detector systems shall be suitable for an operating temperature range of 0 to 122°F.

Gas detector systems shall be MSA Ultima X Series, or approved equal.

2-3.01.01. Sensors. Sensors shall be of the remote mounted diffusion cell type contained in corrosion resistant weatherproof housings. Sensors shall be rated either intrinsically safe or explosion proof, and shall be suitable for the environment in which they will be located. Sensors shall not require any addition of chemical reagents and shall require no routine maintenance other than calibration checks. Combustible gas sensors shall not be adversely affected by exposure to hydrogen sulfide gases. Minimum sensor life shall be 1 year. A sufficient length of cable shall be provided for connecting the sensor to the alarm module enclosure.

2-3.01.02. Receiver-Alarm Modules. Each gas detector system shall be provided with a receiver-alarm module for each sensor. The receiver-alarm modules shall be housed in weatherproof NEMA 4X enclosures suitable for an operating temperature of -4°F to 122°F, with a relative humidity of 5 to 95 percent. Each alarm module shall have a separate, three-digit LED or LCD readout with units of the corresponding sensor engraved on the module face or included on the LCD readout. Each module shall have two independently adjustable alarm points, one labeled "warning" and one labeled "alarm". Each alarm point, plus a module fail alarm point shall actuate separate relays with single-pole, double-throw contacts, rated 3 amp at 120 V ac, and shall illuminate three alarm lights on the module face. Modules shall be of the ac-powered type and shall be designed with failsafe circuitry, so the alarm contacts fail in the alarm condition upon power or sensor failure. Each alarm module shall actuate a local alarm horn or buzzer at the unit, which can be silenced with a button on the unit. Each alarm module shall have an isolated 4-20 mA dc output signal representing the calibrated range of the detector system and capable of driving an external 250 ohm load.

Additional relays shall be provided in the module enclosure as needed to provide additional contacts indicated on the electrical schematic Drawings.

2-3.01.03. Gas Detector Calibration Kit. A calibration kit shall be provided for use in field calibration of each gas detector. The calibration kit shall contain all necessary fittings, calibration gases, and hoses required for not less than 12 field calibration checks of each gas detector, after final acceptance of the system.

2-3.01.04. Spare Sensors. One spare sensor shall be provided for each sensor in the gas detector system. Spare sensors shall be provided in addition to any replacement sensors required during the warranty period, even if the warranty period exceeds the normal expected life of the sensor. Delivery schedule for the spare sensors shall be as recommended by the manufacturer and as coordinated with Owner.

2-3.01.05. Sample Suction Draw System. The gas detection system shall include a packaged sample suction draw system complete with instrument tubing, sample suction pump, and integral controls required to draw gas samples from wet well locations into instrument.

2-3.02. Low Concentration Ozone Analyzers. Not used.

2-3.03. High Concentration Ozone Analyzers. Not used.

2-3.04. Oxygen Purity Analyzers. Not used.

2-3.05. Dewpoint Analyzers. Not used.

2-3.06. Hydrocarbon Analyzers. Not used.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section..

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 17565

TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of all temperature instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the drawings or the Instrument Device Schedule.

When multiple temperature instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System or Equipment Supplier.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1-3 SUBMITTALS. Submittals shall be made as specified in Instrumentation and Control System section.

1-4 SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 7 (or later) operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. TEMPERATURE INSTRUMENTS.

2-2.01. Resistance Temperature Detectors. Each temperature detector shall be a nominal 100 ohm, three or four wire, hermetically sealed, platinum resistance element. The sensing element shall be enclosed in an AISI Type 316 stainless steel outer sheath. Accuracy shall be ± 1°F over the specified operating range.

Each temperature detector shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel. The approximate process insertion length of the thermowell shall be as indicated on the Drawings or in the Instrument Device Schedule. The temperature element shall be spring-loaded in the thermowell. Appropriate temperature head hardware shall be provided with the assembly.

2-2.02. Resistance Temperature Transmitters. Each transmitter shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. The transmitter shall be designed for a resistance temperature detector input and shall have a 4-20 mA dc output or shall have a Foundation Fieldbus output where indicated on the instrument device schedule.

The transmitter shall be of the sensor lead wire compensated type with linearized output to provide an accuracy of ± 0.2 percent of temperature span. The transmitter shall be housed in a weatherproof enclosure designed for mounting directly on or near the thermowell. Shielded lead wire shall be provided as needed between the transmitter and the temperature detector. Each transmitter shall be coordinated with the sensor and thermowell. Transmitters shall be manufactured by Foxboro "RTT20/25", ABB Model TH202/TF202, or Rosemount "644/3144".

Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

Transmitters shall be the indicating type furnished with LCD type digital indicators.

2-2.03. Temperature Switches. Not Used.

2-2.04. Temperature Gauges. Not Used.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of

protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 17566

MISCELLANEOUS INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of all miscellaneous instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple miscellaneous instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1-3 SUBMITTALS. Submittals shall be made as specified in Instrumentation and Control System section.

1-4 SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 7 (or later) operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. MISCELLANEOUS INSTRUMENTS.

2-2.01. Field-Mounted Process Indicators. Field-mounted process indicators that are not integral with the transmitter shall be of the two-wire type that accepts a 4-20 mA dc input and does not require a direct power source connection. Indicators shall have corrosion-resistant, weatherproof housings and shall be suitable for operating over an ambient temperature range of -10 to +55°C. Indicators shall read in engineering units.

A nameplate that describes the indicator service function and the scale units shall be provided on the indicator.

Indicators shall be of the digital display type with an accuracy of 0.1 percent. The display shall be 3-1/2 digit LCD type, with a digit height of not less than 0.5 inch and with a selectable decimal point. Indicators shall be Action Instruments "Series V560", Rosemount “Model 751”, or Precision-Digital "Model PD686."

2-2.02. Milliamp Calibrator. Not used.

2-2.03. Pressure Calibrator. Not used.

2-2.04. Multi-function Instrument Calibrator. Not Used.

2-2.05. Manometer. Not used.

2-2.06. Proximity (Door) Switches. Not used.

2-2.07. Vibration Switches. Not used.

2-2.08. Instrument Shutoff Valves. Instrument shutoff valves shall be provided for instruments as indicated on the Drawings and as detailed in the specifications. The indicated shutoff valves shall be provided by System Supplier for all instruments furnished under the Panel Mounted Instruments section, Flow Instruments section, Pressure and Level Instruments section, Analytical Instruments section, and the Miscellaneous Instruments section. Shutoff valves shall be compatible with the measured process and shall be selected in accordance with the manufacturer’s recommendations for the specified process. Where a process specific compatible material is not indicated, 316 stainless steel construction shall be used where compatible with the process. Unused ports of multi-port gauge valves shall be plugged. An instrument shutoff valve schedule shall be submitted indicating the quantity, material, size, and associated instrument. Permanent tagging of the instrument valves is not required. However, temporary hand-written tags or other means of identification shall be provided to ensure that the appropriate valve is installed for a given instrument.

Instrument shutoff valves shall be D/A Manufacturing, Anderson-Greenwood, or equal.

2-2.09. Limit Switches. Not used.

2-2.10. Modulating Valve Positioners. Not used.

2-2.11. Current-to-Pressure Transducers. Not used.

2-2.12. Valve Position Transmitters. Not used.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 17570

PANELS, CONSOLES, AND APPURTENANCES

PART 1 - GENERAL

1-1. SCOPE. The Panels, Consoles and Appurtenances section covers the furnishing of panels, consoles, and appurtenances as indicated on the Drawings.

This section also describes requirements for panels furnished under other sections whose respective specification refers to this section.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all equipment furnished under the Panels, Consoles and Appurtenances section.
1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated and assembled in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Drawings. General dimensions and arrangements are indicated on the Drawings. System Supplier shall be responsible for coordinating the console and enclosure sizes and arrangements to accommodate the equipment provided.

1-3. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as per The Instrumentation and Control System section.
1-5. SPARE PARTS. Spare parts shall be provided as specified below.

Spare parts	Quantity
Indicating Lamps	10% (Minimum 10) of each type
Fuses	10% (Minimum 10) of each type and size

PART 2 - PRODUCTS.

2-1. PANEL DESIGN AND FABRICATION FEATURES. All panels furnished shall conform to the stipulations of NEMA ICS-6-1993. Unless indicated otherwise on the Drawings, the following paragraphs describe general fabrication specifications for the PLC cabinets, instrument panels, consoles, enclosures, and subpanels.

2-1.01. Piping. Pneumatic tubing shall be 1/4-inch OD, stainless steel with compression fittings. Tubing and fittings shall be as specified in the Miscellaneous Piping section.

2-1.01.01. Fittings. Compression type bulkhead fittings shall be provided near the bottom or the top of the panel for all field connections. Compression nuts and sleeves shall be provided for the field connections. Indicators, recorders, controllers, and other pneumatic devices shall be provided with plugged test connections and shutoff valves for isolation.

2-1.01.02. Valves. All devices shall have separate stainless steel air supply shutoff valves. Valves and compression fittings shall be as manufactured by Nupro, Parker Hannifin, Swagelock, Tylok, or Whitey.

2-1.02. Power Entrance. The power entrance to each panel shall be provided with a surge protection device. Refer to the Instrumentation and Controls section for surge suppression requirements.

2-1.03. Power Wiring. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 14 AWG. Wiring for ac power distribution, dc power distribution, intrinsically safe, and control circuits shall have different colors and shall agree with the color-coding legend on System Supplier's panel wiring diagrams. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame retardant covering rated for not less than 90°C.

All panels shall include a 'Power On' Indicator on the panel exterior door to provide a visual indication of availability of normal power to panel mounted equipment. Normal 'Power On' indicating light shall be 'White' color.

All panel mounted alarm lights shall utilize 'Amber' for color to signify an alarm condition.

2-1.04. Instrument and Control Wiring. All internal panel wiring shall be type MTW stranded copper wiring rated not less than 600 volts. Electronic analog circuits shall be twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Intrinsically safe circuits shall be physically separated from other circuits in accordance with applicable codes. Wires within the panel shall conform to the minimum size as shown in the table below.

Type	Min. Wire Size	Color
AC Control	16 AWG	Red
DC Control	16 AWG	Blue
Analog Circuits	18 AWG Twisted Pair	Black, White

All wiring shall be grouped or cabled and firmly supported inside the panel. Each individual wire in power, control, and instrumentation circuits shall be provided with identification markers at each point of termination. The wire markers shall be positioned to be readily visible for inspection and the identification numbers shall match the identification on the supplier's panel wiring drawings. Wiring shall be bundled in groups and bound with nylon cable ties or routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and with space equal to at least 40 percent of the depth of the duct remaining available for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

2-1.05. Terminal Blocks. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

2-1.06. Backup Power. Power supply to the panels may be from multiple electrical sources as shown on the Drawings, which may be backed by redundant utility feeds, engine generators, or externally mounted uninterruptible power supplies (UPSs) specified in other sections.

2-1.07. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the Instrument Device Schedule and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered labels or tape labels will not be permitted.

2-1.08. Nameplates. Nameplates shall be provided on the face of the panel or on the individual device. Panel nameplates shall have legends and approximate dimensions as indicated on the Drawings and shall be made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the white face into the black layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified under the Device Tag Numbering System paragraph.

2-1.09. Indicating Light Color Designations. Indicating lights are specified in the Panel Mounted Instruments section.

Normal AC Power ‘White’ Lens
Alarm Condition ‘Amber’ Lens

2-1.10. Painting. Interior and exterior surfaces of all steel panels shall be thoroughly cleaned and painted with rust inhibitive (universal) primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils. Color shall be white. One quart of touch-up paint shall be furnished with the panels.

All exterior located panels shall be powder-coated white. Stainless steel surfaces shall be adequately prepared so powder-coating shall not peel or flake.

2-1.11. Panel-Mounted Instruments. Instruments, power supplies, pilot devices, and appurtenances mounted within or on the face of the panel shall meet the requirements specified in Section 17561, Panel Mounted Instruments, for those items unless noted otherwise herein, on the Drawings or, if applicable, within the referring equipment specification section.

2-1.12. Factory Test. Panels shall be factory tested electrically and pneumatically by the panel fabricator before shipment.

2-2. FREESTANDING VERTICAL PANELS. The following paragraphs specify the freestanding vertical panels.

Unless otherwise noted on drawings, all panels shall be constructed of stainless steel or other non-corroding material suitable for the environment and area classification.

Unless otherwise noted on drawings, panels located in unconditioned spaces or outdoors shall be constructed of 316 stainless steel, powder-coated white, including temperature control devices (heat strips and thermostat) for controlling enclosure interior moisture and condensation.

2-2.01. Construction. Panel construction shall be an indoor, dust-tight, completely enclosed cubicle formed from steel structural members and steel plates. The base shall be formed of steel channels, with flanges extending upwards. The base shall be provided with 1/2 inch diameter holes at 12 inch centers so that the base can be bolted to the concrete equipment base. Welds, seams, and edges on all exposed surfaces shall be ground smooth. Suitable lifting facilities shall be provided for handling and shipment.

2-2.02. Structure. Panel structure shall be suitably braced and of sufficient strength to support all equipment mounted on or within, to withstand handling and shipment, to remain in proper alignment, and to be rigid and freestanding. Top, sides, and back shall be fabricated from USS 10 gage or heavier steel sheets, with stationary back suitable for back to wall installation, or designed for rear access with hinged back doors. Doors shall not be greater than 24 inches wide or spaced not greater than 36 inches center to center. Rear access doors shall be fabricated from USS 14 gage or heavier steel.

2-2.03. Panel Front. The front shall be a hinged door, or doors, with mounted instruments and control devices, fabricated from USS 10 gage steel sheet and suitably braced and supported to maintain alignment. Panels with hinged fronts shall be of sufficient width to permit door opening without interference with rear projection of flush mounted instruments.

2-2.04. Doors. Doors shall be essentially full height, having turned back edges and additional bracing to ensure rigidity and prevent sagging. Doors shall be mounted with strong, continuous, piano type hinges. Positive latches, acting from a common door handle, shall hold doors securely compressed at top, side, and bottom against rubber gaskets.

2-2.05. Mounted Instruments. The front shall be stationary, with mounted instruments and control devices, fabricated from 3/16 inch steel plate. Panel fronts shall be suitably reinforced between mounting cutouts and drilling to support instruments and devices without deformation and shall be free from waves and other imperfections, Panel fronts shall be recessed at the base. Adjoining panel sections shall be accurately shop fitted to assure satisfactory assembly in the field.

2-2.05.01. Instrument Arrangement. Panel instruments and control devices shall be arranged in a logical configuration for the plant operators. The centerline of recorders shall be within 3 feet and 5'-9" above the base of the panel for convenient reading and chart replacement. Control switches shall be within 6 feet and 2'-6" above the base of the panel. Indicators may be located within 2'-6" and 6'-6" above the base of the panels. Annunciators and clocks may be mounted near the top of the panels.

2-2.06. Conduit Entrance. The bottom shall be open, and components shall be arranged for external wiring conduit and piping to enter from below. The top shall be provided with nominal 1 square foot removable access plates, which may be drilled to accommodate external wiring and conduit to be installed from above.

2-2.07. Size and Arrangement. Panel dimensions and general instrument arrangement shall be as indicated on the Drawings.

2-2.08. Interior Lighting. Illumination of panel interiors shall be provided by ceiling mounted lamp fixtures spaced at approximately 2'-6"and near the door. Fixtures shall be nominal 40-watt fluorescent tube type, with a common "On-Off" switch near each end door. Duplex-grounded receptacles shall be provided for service and maintenance tools at spacing not greater than 5 feet throughout the length of a panel. The lighting and receptacle circuit shall be fused separately from the instrumentation systems.

2-2.09 Free-Standing Panel Schedule

Panel ID	**Location**	**Furnished By**
ICWRC Headworks PLC	ICWRC Headworks Electrical Room	System Supplier
ICWRC Transfer PS PLC	ICWRC Transfer PS Building Elec. Rm.	System Supplier
SRWRC Headhouse PLC	SRWRC Headhouse Electrical Room	System Supplier

2-3. FILTER CONSOLES. Not used.

2-4. WALL-MOUNTED CABINETS. Cabinets, which contain the system components indicated on the Drawings, shall be suitable for wall mounting and shall meet the NEMA enclosure rating as indicated on the Drawings or, if applicable, in the attached equipment schedules or the referring equipment specification section. The enclosures shall be fabricated from USS 14 gage, or heavier, steel, or fiberglass.

Unless otherwise noted on drawings, all panels shall be constructed of stainless steel or other non-corroding material suitable for the environment and area classification.

Unless otherwise noted on drawings, panels located in unconditioned spaces or outdoors shall be constructed of 316 stainless steel, painted white, and include temperature control devices (heat strips and thermostat) for controlling enclosure interior moisture and condensation.

Cabinets shall be equipped with full size gasketed doors with hinges and a chromium-plated or stainless steel three-point latch. The cabinet shall have a hasp for accommodating a padlock. A screened vent shall be provided in the bottom of enclosures that contain pneumatic devices.

Floor stands shall be provided to support cabinets not fastened to a wall or other support. Floor stands shall be full-depth and shall have a minimum height of 12 inches. Floor stand material and finish shall match the cabinet.

All wall-mounted cabinets shall meet the requirements of the panel fabrication paragraph of this section.

Outdoor cabinets (as indicated on drawings) shall be provided with sunshades constructed of stainless steel and painted white.

2-4.01 Wall-Mounted Panel Schedule

Panel ID	**Location**	**Furnished By**
ICWRC Course Screen 1	ICWRC Screen	Equipment Supplier
ICWRC Course Screen 2	ICWRC Screen	Equipment Supplier
SRWRC Clarifier 1 Grinder	SRWRC Grinder Equipment	System Supplier
SRWRC Clarifier 2 Grinder	SRWRC Grinder Equipment	System Supplier
SRWRC Clarifier 3 Grinder	SRWRC Grinder Equipment	System Supplier
SRWRC Clarifier 4 Grinder	SRWRC Grinder Equipment	System Supplier
SRWRC Scum Pumps 1,2	SRWRC Scum Well 1	System Supplier
SRWRC Scum Pumps 3,4	SRWRC Scum Well 2	System Supplier
SRWRC Primary Sludge Pump 2	SRWRC Sludge Pumps	System Supplier
SRWRC Primary Sludge Pump 3	SRWRC Sludge Pumps	System Supplier
SRWRC Primary Sludge Pump 6	SRWRC Sludge Pumps	System Supplier
SRWRC Primary Sludge Pump 7	SRWRC Sludge Pumps	System Supplier
SRWRC Primary Sludge Pump 8	SRWRC Sludge Pumps	System Supplier
SRWRC Sludge Drain Pump 1	SRWRC Sludge Pumps	System Supplier
SRWRC Sludge Drain Pump 2	SRWRC Sludge Pumps	System Supplier
SRWRC Chemical Dosing PLC	SRWRC N Primary Sludge PS	System Supplier
SRWRC Ferric Chloride MP1	SRWRC N Primary Sludge PS	Equipment Supplier
Panel ID	**Location**	**Furnished By**
SRWRC Ferric Chloride MP2	SRWRC N Primary Sludge PS	Equipment Supplier
SRWRC Ferric Chloride MP3	SRWRC N Primary Sludge PS	Equipment Supplier
SRWRC Chemical Ethernet Equipment	SRWRC N Primary Sludge PS	System Supplier

2-5. FIBER OPTIC TERMINATION CABINETS (FOTC).
Fiber optic termination cabinets (also commonly referred to as patch panels) shall be furnished to terminate fibers at the Fiber Optic Modules, and any other data highway attached equipment. The FOTC shall be located within free-standing EIA panels listed under section 17570-2.6 and shall meet the following requirements:

The termination cabinet shall be the rack mounted type, having provisions for terminating multiple fiber optic cables. Splice trays, strain relief cable attachment points, fiber organizers and bend radius hardware shall be furnished with each termination cabinet

Panel size shall be suited to the number of fibers to be terminated within the cabinet. Bayonet/flanged couplings shall be furnished and mounted for each fiber to be terminated.

Fiber terminations shall be spliced to pigtail cables (specified below) having ST connectors. The pigtails shall be terminated in an orderly method.

Fiber Optic Termination Cabinets shall be OFS Technologies “Fiber Interconnect Unit”, Corning Cable Systems “WCH Series”, or equal.

2-6. FREESTANDING EIA 19-INCH RACK ENCLOSURES. An open frame equipment distribution rack shall be provided for mounting network equipment provided as rack-mounted, including switches, firewalls, routers, and patch panels. The rack shall be black painted steel or painted aluminum construction with fully tapped, standard 18.3 inch hole-to-hole centers and shall include all hardware and accessories including frame, shelves, and raceways as specified and as shown on Drawings. Rack enclosures shall be as manufactured by Belkin, Hoffman, or equal.

2-6.01 EIA 19-INCH Rack Enclosure Schedule

Panel ID	**Location**	**Furnished By**
ICWRC Transfer PS	ICWRC Transfer Pump Station Electrical Room	System Supplier
ICWRC Headworks	ICWRC Headworks Building Electrical Room	System Supplier
ICWRC Power Gen	ICWRC Power Generator Building	System Supplier
SRWRC Headhouse	SRWRC Headhouse Building Electrical Room	System Supplier

2-7. DATA SERVER ENCLOSURES. Not used.

2-8. WALL MOUNTED INSTRUMENT SUBPANELS. Not used.

2-9. CONTROL SYSTEM CONSOLES AND ENCLOSURES. Not used.

PART 3 - EXECUTION

3-1. GENERAL INSTALLATION REQUIREMENTS. Installation requirements are specified in the Instrumentation and Control System section. In addition, equipment furnished under this section shall conform to the following manufacturing stipulations.

3-1.01. Piping. All tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipment. Flexible polyethylene tubing shall be used to connect devices mounted on hinged doors.

3-1.02. Wiring. All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40 percent of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

3-1.03. More Than One Panel. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic Drawings.

End of Section

SECTION 17580

AC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1-1. SCOPE. The Uninterruptible Power Supply section covers the furnishing of a complete on-line uninterruptible power supply (UPS) as indicated on the DRAWINGS.

The system shall convert incoming single phase 60 Hz, power into dc power, maintain and charge backup batteries and reconvert outgoing power into a sinusoidal single phase, 60 Hz, ac power source. The UPS system shall consist of a rectifier, battery charger, batteries, inverter, integral static bypass switch, and maintenance bypass switch or transfer switch as required. The UPS system shall include all UPS power distribution terminals, circuit breakers, junction boxes, and connectors required for a complete and working system.

The UPS System shall be installed and wired as indicated on the Electrical DRAWINGS.

Additional accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.

1-1.01. Control System. The Instrumentation and Control System Section shall apply to all equipment furnished under the Uninterruptible Power Supply section.

1-1.02. Control System Loads. The UPS shall supply Control System and other loads as indicated on the DRAWINGS or herein.

UPS designations are as follows:

Load Description	**UPS Location**	**UPS Load**
ICWRC Headworks	ICWRC Headworks Building Electrical Room – Headworks PLC panel	6 KVA
ICWRC Transfer PS	ICWRC Transfer Pump Station Electrical Room – Transfer PS PLC panel	6 KVA
SRWRC Chemical	SRWRC North Primary Sludge Pump Station - Chemical PLC panel	3 KVA
SRWRC Headhouse	SRWRC Headhouse Building – Headhouse PLC panel	6 KVA

1-2. GENERAL. Equipment furnished under the Uninterruptible Power Supply section shall be fabricated and assembled in full conformity with the DRAWINGS, SPECIFICATIONS, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by ENGINEER.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this SPECIFICATION differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. DRAWINGS. Supplementing this section, the DRAWINGS indicate locations and arrangement of enclosures and provide one-line diagrams regarding the connection and interaction with other equipment.

1-2.03. Nameplates. Each UPS shall be identified with a suitable engraved nameplate mounted on the top front. A nameplate shall also be provided for each of the external transfer switches. The nameplates shall be made of laminated black and white plastic. The lettering shall be bold, not less than 1/4 inch square, engraved by cutting through the white outside layer so that the letters appear black.

1-3. SUBMITTALS. In addition to the Instrumentation and Control System section, all material and equipment documentation shall be submitted for review as specified in the SUBMITTALS section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

a.	Equipment and materials descriptive literature and DRAWINGS shall show the specification paragraph for which equipment applies.
b.	Sheets or DRAWINGS showing items not applicable to this system, or not requiring review, shall contain clear indication as to which section or sections require review.
c.	Functional line diagrams showing all major system components and external connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.
d.	A report certifying that the UPS will provide the required backup time at the specified UPS loading and UPS ambient temperature. The report shall include anticipated continuous electrical load calculations, backup time calculations and shall indicate the battery end-voltage used in the analysis.
e.	Documentation showing the physical dimensions, weight, and

	wiring connection points of the UPS/battery system being provided.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. All equipment, enclosures, and accessories shall be designed, assembled and connected in accordance with the requirements of these SPECIFICATIONS and the DRAWINGS. Enclosures shall be NEMA Type 12.

2-1.01. System Design Requirements. The UPS system(s) have the following estimated capacity and rated for the following voltages. The SYSTEM SUPPLIER is to confirm the required capacity and adjust accordingly. The UPS shall have an excess capacity of 50% of the estimated load.

The UPS system(s) shall have the following ratings and features.

Input voltage at 60 Hz, +10 to -15 percent	120/240 single phase
Output voltage at 60 Hz single phase	120/240V
Minimum Back up time required (minutes) at connected load.	25 Minutes
Minimum UPS Size	3 KVA
N+X Redundancy	N+1 Redundancy
Battery Modules	As Required for Capacity & Backup Time
Chassis Size	12 slot Floor Mounted

Capacity, peak (minimum)	150 percent of continuous power rating for 10 seconds.
Input Power Factor	0.95
Input Frequency	60 Hz (+/- 3 Hz)
Topology	True online, double conversion N+X power and logic redundancy

Surge Suppression	IEEE/ANSI C62.41
Output On-Utility Voltage Regulation	+/- 3% of nominal
Output On-Battery Voltage Regulation	+/- 3% of nominal
Output Frequency Regulation	+/- 3 Hz online, +/- 1 Hz on battery
Output Efficiency	89 normal operation
Harmonic distortion (max)	5 percent.
Operating temperature-humidity	0 to 40°C; 50 to 90 percent relative humidity, non-condensing.
Battery Type	Sealed lead-acid maintenance free
Battery Recharge time (max)	<2 hours from complete discharge to 80% capacity
Relay Dry Contact Outputs	Low battery, on inverter, fault, and on bypass
Optional RS-232 Modbus Serial Link	Not Used
Optional Internal Bypass Switch	Not Used
Optional External Bypass Switch	As required per Section 2.5
Optional Automatic Transfer Switch	Not Used
Optional RS-232 Modbus Slave serial communications port	No Used
Installation	Freestanding

2-1.02. Acceptable Manufacturers. The UPS shall be as manufactured by Eaton-Powerware Corp. Powerware Model 9170+ with N+1 Redundancy for any UPS between 3 KVA and 18 KVA, or approved equal.

2-1.03. Terminal Blocks. Wiring for external circuits, including all alarm contacts, shall be brought to grouped terminal blocks located for convenient connection. Provisions shall include suitable marked terminal blocks for connection of No. 12 AWG control wiring, and for input/output power conductors as sized on the DRAWINGS. Terminal designations shall agree with manufacturer's wiring diagram.

2-2. BATTERY CHARGER/RECTIFIER AND BATTERIES. The battery charger and the rectifier shall have the following characteristics:

a.	The rectifier shall convert the incoming ac power to dc power to

	energize the static inverter.
b.	The battery charger shall supply a float current to the batteries to maintain them at a fully charged state while incoming power is being provided. The charging voltage shall be temperature-compensated over the entire operating temperature range to avoid overcharging or undercharging the batteries. The battery charger shall automatically apply an elevated voltage (equalization charge) to the batteries if and as required by the battery manufacturer.
c.	The battery shall provide backup power for the UPS when incoming commercial power is not available. The battery cells shall be gell cell or sealed lead-acid type. The batteries shall be integral to the UPS unless additional external batteries are required to meet the time requirement. Batteries shall have capacity to supply the dc power to the UPS while operating at full load for a period of not less than as required in Table 2-1.01 at 25 deg C. The battery shall have an expected life of 5 years and shall carry a one-year warranty.

2-3. STATIC INVERTER. The solid-state inverter shall employ solid state switches and other devices for converting direct current power to essentially sinusoidal alternating current power. The static inverter shall conform to the following characteristics and requirements.

a.	Automatic Synchronization: During normal operation, the inverter shall provide power to critical loads. The utility electric system will act as an alternate supply. Inverter equipment shall include stable solid-state devices designed to automatically maintain inverter output in phase with the utility electric system.
b.	Overload, Short Circuit, and Load Loss: The inverter shall have input and output fuses and other equipment necessary to protect from overload, short circuit, and 100 percent loss of load. Current limiting features shall also be provided.

c.	Loss of Supply Voltages: The inverter shall include protective devices to prevent damage resulting from excursion, loss, or restoration of its synchronization voltage and its dc input voltage and any inrush current occurrences associated with such conditions.

2-4. EXTERNAL AUTOMATIC TRANSFER SWITCH. Not Required.

2-5. MAINTENANCE BYPASS SWITCH. Provide an external Make Before Break (MBB) Powerware Model BPE14MBB1A 80A rated external maintenance bypass switch or UPS manufacturer supplied equal.

2-6. INPUT/OUTPUT CONNECTIONS. A hardwired terminal strip shall be provided for UPS input and UPS output wiring connections.

2-6.01 Modbus Communications – UPS shall be provided with RS-232C / RS-485 serial port to communicate status and diagnostics using Modbus protocol.

2-7. CONTROL, INDICATION AND ALARM. Controls, indicators and alarms shall be provided as a part of the UPS. Control buttons and LED indicators shall be provided on the UPS panel and shall be permanently labeled.

2-7.01. Controls. A UPS Self Test, and system "ON" and "OFF" buttons for battery and utility power shall be provided.

2-7.02. Indication. An LED display for percent UPS load capacity and percent remaining battery capacity shall be provided.

LED indicators for inverter ready, frequency, battery voltage, overload, over temperature, and impending shutdown conditions shall be provided.

LED indicators for normal mode, battery mode, and bypass mode shall be provided.

2-7.03. Remote Status and Alarms. The UPS shall have the following provisions for remote status and alarms.

a.	UPS Common Fault – Dry contact
b.	UPS 'On Battery' – Dry Contact

c.	UPS Low Battery – Dry contact
d.	UPS Bypassed – Dry Contact

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. Installation requirements are specified in the Instrumentation and Control System section and shall be coordinated with the Electrical section.

End of Section

Section 17590

NETWORK SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. The Networks Systems section covers the furnishing of all hardware and software for network systems for the Instrumentation and Control System. Principal components of the network systems shall be as indicated on the block diagram Drawings and as described below.

System Supplier shall furnish all necessary equipment, interconnecting cables, accessories, and appurtenances for proper network operation and to meet the functional requirements indicated on the Drawings and specified herein. Configuration of all hardware shall be provided by the System Supplier.

Equipment and services provided under the Networks section shall be subject to the general requirements specified in the Instrumentation and Control System section. Supplementing this section, network data, special requirements, and options may be indicated on the Drawings

1-1.01. Control System. The Instrumentation and Control System section shall apply to all systems described herein. All applicable requirements specified in the Instrumentation and Control System section shall apply to equipment and services provided herein.

1-1.02. Network Functional Description. The network system shall provide communications between the operator workstations, servers, and PLCs.

1-2. GENERAL. System Supplier shall select the equipment for its superior quality and the intended performance. The System Supplier shall install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the following requirements.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings indicate locations and arrangement of hardware and enclosures, provide mounting details, and may show other information regarding the connection and interaction with other equipment.
1-2.03. Governing Standards. Governing Standards for network systems shall be as

specified in the Instrumentation and Control System section.

1-2.04. Power and Instrument Signals. Unless otherwise specified, electric power supply to the network equipment will be unregulated 24 volts dc or 120 volts ac.

1-2.05. Appurtenances. Special power supplies, special cable, special grounding, and isolation devices shall be furnished for proper performance of the equipment.

1-2.06. Interchangeability and Appearance. To the extent possible, components used for similar types of functions and services shall be the same brand and model line. Similar components of different network hardware shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

1-2.07. Programming Devices. A programming or system-configuring device, or software required for programming, shall be provided for systems that contain any equipment that requires such a device or software for routine maintenance and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup. Programming software shall be licensed to the Owner.

1-3. SUBMITTALS. Submittals shall be made in accordance with the requirements of the Instrumentation and Control System section and as listed below.

The submittals shall include the following items for the Network Design submittal (to be provided with the First Stage Submittals):

A complete network topology diagram, detailing all hardware, cabling and the interconnections between all connected equipment. Interconnections to existing installed equipment and Owner-furnished equipment shall be included in the diagram.

A complete listing of IP addresses to be assigned to all equipment furnished under this contract shall be provided. The assignment of IP addresses shall be coordinated with the Owner.

All above documentation shall also be provided in the O&M manuals.

1-4. DELIVERY, SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

1-5. CONNECTION TO OWNER NETWORKS. Network hardware and software provided shall be compatible with the Owner's existing network systems wherever a

system interconnection is provided. System Supplier shall verify existing systems to ensure compatibility.

All connections to the Owner's existing network shall be fully coordinated between the Owner and the System Supplier. Prior to connecting to the existing network, the System Supplier shall provide a written request to the Owner for an Owner's representative to be available when existing systems are disconnected and at the time of any new connections.

1-6. COORDINATION WITH OWNER. The System Supplier shall coordinate all demolitions, installations and rework on the existing networks with the Owner and the Engineer. No work shall be performed without the written consent of the Owner. The System Supplier shall submit a written request to perform work on the existing network, including date, time, scope of work, length of time, and any Owner's support that may be required.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum Ethernet network device stipulations.

2-2. NETWORK CABLING SPECIFICATIONS. Individual network equipment and related devices shall be coordinated with items provided in the following sections:

17591 Network Cable

2-3. ETHERNET NETWORK HARDWARE. Ethernet network hardware shall be provided as specified and/or as shown on the Drawings. All specified functionality of provided Ethernet network equipment shall adhere to the IEEE 802 standards. Ethernet Hubs will not be accepted for network systems. Ethernet switches shall be provided to connect multiple network segments together, selectively forwarding traffic between the segments.

2-3.01. Ethernet Switches. Each switch shall include the following functionality:

a. Switch shall support the quantity of 10/100/1000BaseTX ports and 10BaseFL/100BaseFX/1000BaseLX Fiber ports to meet the functionality indicated in this specification and as shown on the Drawings. Switches shall have a minimum of 10/100/1000Base-T, RJ-45 ports. A minimum of 20% spare ports shall be provided for the installed system.

b. Each switch connection shall automatically sense the network speed of

the devices to which it is connected.

c. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.

d. Prioritization: IEEE 802.1p QoS Support.

e. Support for Optional Redundant Power Supply as required on Drawings.

f. Management: Fully Managed Switch with support for SNMP v.3., and port mirroring.

g. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

h. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 40C.

Switches shall be Cisco “Catalyst Series”, Hewlett Packard “Procurve Switch” series, 3Com “SuperStack II” series, or equal.

2-3.02. Industrial (Panel-Mounted) Ethernet Switches. Each switch mounted in process areas shall include the following functionality:

a. Ports: Switch shall support the quantity of 10/100BaseTX ports and 100BaseFX fiber ports to meet the functionality indicated on the Drawings, with a minimum of 20% spare auto-negotiating 10/100Base-T, RJ-45 ports, and two multimode fiber uplink ports. A minimum of four UTP ports shall be provided.

b. Each switch connection shall automatically sense the network speed of the devices to which it is connected.

c. Capable of ring-based media redundancy with 30 ms recovery time.

d. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.

e. Prioritization: IEEE 802.1p QoS Support.

f. Network Segregation: Port VLAN.

g. Management: SNMPv3 and Browser-based management shall be supported.

h. IGMP snooping supported.

i. LED indication of the link activity for each port.

j. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 60C. Optional -40 to 60C rating availability.

k. Redundant 24 VDC power supply inputs

l. Conformal coating option for use in hazardous environments.

m. Mounting: DIN-rail mounted suitable for panel installation.

n. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

Switches shall be GarretCom Magnum 6K Series, Hirschmann RS-20 series, Moxa 508A series, N-Tron 708FX series, SIXNET SL-8MG Series, or equal.

2-3.03. Network Routers. Not used.

2-3.04. Network Firewall. Not used.

2-3.05. Ethernet Connectors. Ethernet wiring connectors shall be RJ-45 male modular (8P8C) plug connectors.

2-3.05.01. Standard RJ45 Connectors. Standard connectors shall be polycarbonate, clear connectors. Connectors shall conform to RJ-45 and ISO 8877 standards. Contacts shall be gold plated with a 0.5A current rating and a -25º to 60º C temperature rating. Connectors shall accept unshielded Cat-5e or Cat-6, AWG 24, solid conductor cable.

2-3.05.02. Industrial RJ45 Connectors. Industrial connectors shall be an eight position industrial connector for use in manufacturing environments. Connectors shall meet the TIA/EIA-568-B.2 standard for Cat-5e or Cat-6 requirements. The connector shall incorporate an IP67 rated seal and shall provide protection from dust and temporary immersion in water. A tethered protective cap shall be provided. The connector shall accept a non-shielded Cat-5e or Cat-6 solid twisted pair cable. Connectors shall be Panduit Industrial TX5e, or equal.

2-3.05.03. Industrial RJ45 Receptacles. Industrial receptacles shall be an eight position industrial, panel mounted pass through receptacle. Receptacles shall meet the TIA/EIA-568-B.2 standard for Cat-5e or Cat-6 requirements. The receptacle shall incorporate an IP67 rated seal and shall provide protection from dust and temporary immersion in water. A tethered protective cap shall be provided. The receptacle shall accept a non-shielded Cat-5e or Cat-6 solid twisted pair cable. Receptacles shall be Panduit Industrial TX5e, or equal.

2-3.06. Media Converters. Not Used.

2-3.07. Frame Relay Routers. Not used.

2-4. ETHERNET NETWORKS SOFTWARE. Not used.

2-3. SPARE PARTS. Spare parts shall be provided as specified below.

Spare parts	Quantity
Switches	1 of each type

PART 3 - EXECUTION

3-1. NETWORK INSTALLATION REQUIREMENTS. Additional network installation requirements are specified in the Instrumentation and Control System section. Networks shall be installed and tested in accordance with the following requirements.

3-2. NETWORK CONFIGURATION. The System Supplier shall fully configure all network devices. All device selections shall be fully coordinated with the Owner to ensure compatibility with existing systems and standards.

3-2.01. Ethernet Switches. The System Supplier shall fully configure all Ethernet switches. The following shall be configured:

a. Unused ports shall be disabled for security purposes.

b. Spanning Tree or other appropriate redundancy scheme shall be configured for all redundant links. Trunking or other bandwidth sharing redundancy schemes shall be utilized where available to minimize switching times, and increase available bandwidth.

c. Management Password Security

d. Quality of Service, with any traffic to/from PLCs getting priority over all other traffic.

3-2.02. Routers. Not used.

3-2.03. Firewalls. Not used.

3-2.04. Network Configuration Report. The System Supplier shall provide a configuration report to the Owner detailing all connections, addresses, and port assignments

3-2.05. Management Software. Management software shall be fully configured for all network devices provided.

3-3. NETWORK TESTING. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test.

3-3.01. Field Testing. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test. Specific testing requirements are described in the individual network specification sections.

3-3.02. Systems Check. A technical representative of System Supplier shall participate in the checkout of network systems. Systems check requirements shall be as specified in the Instrumentation and Control System section.

3-3.01. Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

3-3.02.02. Ethernet Network Minimum Test Requirements. The following minimum tests are to be performed by the System Supplier:

a. Verify Link Integrity Status LED is lit on both sides of each link

b. Verify proper operation and failover of each redundant component and redundant link.

c. Verify alarming of each link failure.

d. Verify bandwidth Usage

3-3.02.03. Ethernet Network Test Reports. Upon completion and testing of the installed Ethernet network, the System Supplier shall submit test reports to the Engineer in printed form. Test reports are to show all test results performed by the System Supplier for each port and piece of equipment. Date of calibration of the test equipment is also to be provided.

3-4. NETWORK TROUBLESHOOTING. It is the System Supplier's responsibility to provide trouble-free and reliable networks. The System Supplier shall employ any means necessary to ensure operational networks. The System Supplier shall obtain any needed test equipment, including but not limited to time-domain reflectometers, protocol analyzers and network sniffers, to troubleshoot any problems. The System Supplier shall utilize the services of a trained and certified Network Engineer that is regularly involved in troubleshooting network problems, in the event that operational or reliability problems exist. Acceptable certifications include Cisco CCNP, Cisco CCIE, or Network Professional Association Certified Network Professional (CNP).

3-5. CUSTOMER TRAINING. Training for networks is covered under Network Training in the Instrumentation and Control System section.

End of Section

Section 17591

METALLIC AND FIBER OPTIC COMMUNICATION CABLE AND CONNECTORS

PART 1 - GENERAL

1-1. SCOPE. The Network Cable section covers the furnishing and installation of cable systems to provide communications for the Computer Control System as indicated on the Drawings.

Accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.

Equipment and services provided under this section shall be subject to the General Computer Control System Requirements specified in the Instrumentation and Control System Section and the Ethernet Networks section. Supplementing the Network Cable section, network data, special requirements, and options are indicated on the Drawings.

1-2. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

1-2.01. Qualifications. The name, address and telephone number of the proposed contractor or subcontractor, including specific personnel to perform the work shall be included with the submittals. Provide the experience record of the subcontractor and personnel in performing work similar to that specified. Include the agency, contact person, and telephone number of at least three (3) previous network installation projects completed by the proposed subcontractor. The Engineer shall review and approve the network installation subcontractor and personnel prior to any of the related work being performed. This review will be conducted during the project submittal phase, as described below.

1-2.02. Drawings and Data. All material and equipment documentation shall be submitted for review in accordance with the Submittals section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment.

Product data shall include the following in the Submittals section:

a. Cut sheets and catalog literature for proposed fiber optic cable, and fiber optic cable accessories (pigtails, connectors, etc.)

b. Manufacturer specifications and data that clearly shows that the fiber optic cable meets all requirements specified herein.

c. Sample of the proposed cable.

d. Physical dimension drawings of all fiber optic accessories.

e. Proposed fiber identification sequence and labeling.

f. Provide off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.

g. Provide a Recommended Spare Parts List (RSPL).

h. Provide a list of recommended special tools for fiber installation testing or maintenance.

1-2.03. Operations and Maintenance Manuals. Operation and Maintenance Manuals shall have the following items included in addition to those items specified in other sections:

a. Description of all components.

b. Methods of connection.

c. Connection diagram.

d. OTDR trace plots for all fibers.

1-3. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section.

1-4. QUALIFICATIONS. Due to the specialized nature of installing, splicing, terminating, and testing optical fiber cable, the Contractor shall utilize personnel who are experienced in such practices. The installing Contractor or Subcontractor shall have performed similar installation and testing work on at least three projects of similar size and complexity. The personnel assigned to the installation and testing shall also have experience on at least three projects of similar size and complexity.

PART 2 - PRODUCTS

2-1. GENERAL. All fiber optic cable, fiber optic hardware and accessories shall be designed, assembled and connected in accordance with the requirements of these Specifications and the Drawings.

2-2. ETHERNET UNSHIELDED TWISTED PAIR (UTP) CABLE. Ethernet cables and connectors shall be provided for a complete and working system, and/or as shown on the Drawings. Cable for Ethernet wiring shall be UTP Cat-5e or Cat-6 cable. Cable shall be Cat-5e for network speeds up to 100 MHz, and Cat-6 for network speeds greater than 100 MHz. Jacket color coding for cables shall be as follows:

a.	Standard Cat-5e PLC Networks.	Blue
b.	Standard Cat-5e Enterprise Networks.	White
c.	Standard Cat-6.	Yellow
d.	Crossover cables.	Red

Cable shall meet the following characteristics:

2-2.01. Category 5e UTP Cable. Not used.

2-2.02. Category 6 UTP Cable. Cat-6 cable shall meet the following requirements:

a. 24 AWG
b. 4 pair solid strand FEP Teflon insulation
c. 100 Ohm impedance
d. 1-250 MHz frequency range
e. Min attenuation 19.9 dB
f. 100 Ohm impedance
g. Min NEXT 44.3dB/100MHz
h. Min PS-NEXT 42.3dB/100MHz
i. Min ELFEXT 27.8dB/100MHz
j. Min PS-ELFEXT 24.8dB/100MHz
k. Min return loss 20.1 dB/100 MHz
l. Max delay skew 45 ns
m. Max propagation delay 540 ns

Plenum rated cable shall have FEP insulation jacketing and FEP insulation for conductors. Non plenum rated cable shall have PVC insulation jacketing and polyethylene insulation for conductors. Cat-6 cable shall be Belden 1872 or equal.

2-2.03. Ethernet Patch Cables. Pre-wired and terminated patch cables with RJ-45 connectors and lever protecting boot shall be furnished for all connections to computers, network equipment, and controller equipment except where physical conditions (i.e. length over 12 ft. or conduit size) require un-terminated wire to be installed. Patch cables shall be Cat-5e for networks speeds up to 100 MHz, and Cat-6 for networks speeds greater than 100 MHz and shall meet the requirements of Cat-5e and Cat-6 cable specified in this section. Straight through cables shall be wired using the T568-B standard for both connectors as shown in section 3-1.01. Crossover cables shall be wired using the T568-A standard for one connector and the T568-B standard for the opposite end.

2-3. FIBER OPTIC CABLE. The fiber optic cable must meet all of the requirements of the National Electrical Code (NEC) Section 770:

b. Riser Applications – Applicable Flame Test UL 1666.

c. Finished cables shall conform to the applicable performance requirements of Table 8-6 and 8-7 in the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Fiber Optic Premises Distribution Cable (ICEA S-83-596).

d. Every fiber in the cable must be usable and meet required specifications.

e. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

f. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

g. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kPSI.

h. All optical fibers shall be 100 percent attenuation tested. The attenuation shall be measured at 850 nm, and 1300 nm for multimode fibers. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of 5 years. These values shall be available upon request.

i. The storage temperature range for the cable on the original shipping reel shall be –40oC to +70oC. The operating temperature range shall be –40oC to +70oC. Testing shall be in accordance with FOTP-3.

j. The attenuation specification shall be a maximum attenuation for each fiber at 23 + 5OC.

k. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB at 850 nm/1300 nm (multimode) in any one kilometer length of fiber.

l. Required Fiber Grade: Maximum Fiber Attenuation at 850 nm shall be 3.5 dB/km.

m. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm.

n. The cable shall contain 12 fibers. Each buffer tube shall contain up to 12 fibers.

o. The fibers shall not adhere to the inside of the buffer tube.

p. Each fiber shall be distinguishable from others by means of color coding in accordance with TIA/EIA-598-A, “Optical Fiber Cable Color Coding.”

q. The fibers shall be colored with ultraviolet (UV) curable inks.

r. Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-A, “Optical Fiber Cable Color Coding.”

s. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

t. The buffer tubes shall be resistant to kinking.

u. The cable jacket color shall be black.

v. Fibers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fibers shall be placed so that they do not interrupt the consecutive positions of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 3.0 nm in outer diameter.

w. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

x. The outer cable jacket shall be marked with the manufacturer’s name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet (e.g. “62.5/125 MICRON – TYPE OFNR – (UL) 00001 Feet”). The print color shall be white.

y. The cable shall be all-dielectric.

z. The cable shall be gel-free.

aa. The outside diameter of the cable shall not exceed 7 mm.

ab. Flammability – All cables shall comply with the requirements of the 1996 NEC Article 770. All cables shall pass UL 1666.

Fiber optic cable shall be as manufactured by Corning Cable Systems, Belden, Commscope, TE Connectivity, or equal.

2-3.01. Multimode Fiber. Multimode fiber shall be 62.5/125µm core diameter cable.

62.5 µm core diameter multimode fiber optic cable shall meet the following requirements:

a. The multimode fiber utilized in the cable specified herein shall meet EIA/TIA-492AAAA-1989, "Detail Specification for 62.5 m Core Diameter/125 m Cladding Diameter Class Ia Multimode, Graded Index Optical Waveguide Fibers."

b. Core diameter: 62.5 ± 3.0 micrometers.

c. Cladding diameter: 125.0 ± 2.0 micrometers.

d. Core-to-Cladding Offset: ≤ 3.0 micrometers.

e. Cladding non-circularity: ≤ 2.0%. Defined as: [1-(min. cladding dia. + max. cladding dia.)] X 100.

f. Core non-circularity: ≤ 6.0%. Defined as: [1-(min. core dia. + max. core dia.)] X 100.

g. Coating Diameter: 245 ± 10 micrometers.

h. Graded index.

i. Numerical Aperture: 0.275 ± 0.015.

j. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.

k. Minimum Bandwidth Requirement shall be 160/500 MHz-km at 850/1300 nm.

2-3.02. Single mode Fiber. Not used.

2-3.03. Fiber optic cable connectors.
All optical fibers shall be terminated with connectors that are type ST for multimode cable and type SC for single mode cable.

2-3.03.01. Epoxy Connectors. Epoxy connectors shall be provided to terminate each fiber in the cable. Connector style, ST, SC, or other, shall be coordinated with the patch panels and field devices that will interface directly with the cable. Connectors shall be compatible with the supplied cable. Connector loss shall be no greater than 0.3 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each termination. Connectors shall be Corning Cable Systems Connectors, or equal.

2-3.03.02. Crimp Style Connectors. Not used

2-3.04. Fiber Optic Jumper Cables. Fiber optic jumper cables shall be furnished and installed for equipment interfacing and between termination cabinets. The jumpers shall meet the following requirements:

a. The jumpers shall be 62.5/ 125 microns, multimode for operation at 1300 nm. They shall be tight-buffered and be protected by Kevlar-type strength material.

b. The jumpers shall be supplied with connectors on each end. Connector types (ST, SC, LC, etc.) shall be matched to the equipment provided. Jumpers shall be sized to provide a single connection between the fiber optic hardware being connected.

2-4. PLC COMMUNICATIONS MEDIA. Not used

2-6. ETHERNET CABLE TEST EQUIPMENT. Not used

PART 3 - EXECUTION

3-1. INSTALLATION. The System Supplier shall be responsible for the coordination of the installation of all cable furnished hereunder. The System Supplier shall be responsible for the termination of all cable furnished hereunder.

3-1.01. Cable Damage. If the cable becomes damaged during installation, the Contractor shall stop work and notify the Engineer immediately. The Owner and Engineer will decide whether to replace the entire reel of cable or to install a splice at the damaged section. If the Owner decides to replace the entire reel of cable, the Contractor shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the Owner. Installation of new cable to replace damaged cable shall not be a basis of extra payment or contract completion time. In addition to installation of the new cable, the Contractor shall reimburse the Owner for the entire cost of the replacement reel of cable. This cost will be withheld from the contract price. If the Owner decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at the Contractor's expense.

3-1.02. Ethernet Cable Installation. Straight through cables shall be wired using the T568-B standard for both connectors as shown in the table below (connector pin numbers are left to right with the clip down). Crossover cables shall be wired using the T568-A standard for one connector and the T568B standard for the opposite end as shown in the table below.

Connector Pin	568A Wiring Conductor	568B Wiring Conductor
1 2	White/Green Green	White/Orange Orange
3 6	White/Orange Orange	White/Green Green
4 5	Blue White/Blue	Blue White/Blue
7 8	White/Brown Brown	White/Brown Brown

3-1.03. Fiber Optic Cable Installation. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification. Fiber optic cable installation shall meet the following requirements:

a. All fiber optic cable shall be installed, terminated, and tested by the System Supplier or his fiber subcontractor as specified above.

b. In pulling the cable, strain-release, or other tension limiting devices shall be used to limit the pull tension to less than 600 lbs.

c. Minimum bend radius restrictions shall be satisfied both during and after cable installation.

d. Horizontal, unsupported cable runs shall be supported at continuous distances of 5 feet or less.

e. All conduit and cabinet entrances shall be sealed with RTV or other re-enterable sealant material to prevent ingress of water, dust or other foreign materials.

f. Cable routing within occupied office areas shall conform to Federal, State, and local electrical and fire codes.

g. Any non-terminating (field) splices shall be documented as to the physical location and cable meter mark (prior to stripping). Field splices shall be OTDR-tested and documented prior to final cable acceptance testing.

h. Fiber optic cables shall be installed in accordance with NECA 301-2004, Installing And Testing Fiber Optic Cables.

i. A service loop of 15 to 20 feet of cable shall be left in any termination panel or pullbox during cable installation.

3-2. CABLE TESTING. After the network cabling has been installed, each network cable shall be tested.

3-2.01. Test Equipment. Unless specified otherwise, all test equipment for the

calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

3-2.02. Ethernet UTP Cable Testing. The System Supplier shall utilize the previously specified test equipment, and additional tools as needed to validate the Ethernet UTP cable installation. All test equipment shall bear current calibration certification from a certified calibration laboratory, as appropriate. Each cable shall be tested for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs. A check off sheet shall be utilized, shall be signed by the technician testing the cables, and shall be submitted for approval. Any identified faults shall be corrected at no additional cost.

3-2.03. Fiber Optic Cable Testing. Acceptance testing of the data highway (fiber and electronic equipment) shall be conducted as a part of integrated system field testing, as specified elsewhere. Prior to such tests, however, the fiber optic cable shall be tested as specified herein.

The System Supplier, or his fiber subcontractor, shall conduct fiber optic cable testing as specified below. All testing following field installation shall be witnessed by the Engineer. The Contractor shall bear the cost for factory witnessed testing in accordance with Section 01610, General Equipment Stipulations. A test plan shall be submitted prior to the proposed test dates. The test plan and procedures shall be mutually agreed to prior to conducting the tests.

Each optical fiber of each fiber optic cable shall be OTDR (Optical Time Domain Reflectometer) tested on the reel at the factory, on the reel upon arrival at the jobsite, and after installation and termination. For each fiber, an OTDR (Optical Time Domain Reflectometer) trace soft/hardcopy is required to be provided to the Owner and Engineer. OTDR traces shall be provided for each test (at the factory, on the reel at the job-site, and after installation). A 100 foot launch cable shall be spliced to each fiber for each fiber OTDR test, to ensure accurate results. This end-to-end trace shall be performed from BOTH ends of the fiber. Also for each fiber, an end-to-end power attenuation (insertion loss) test shall be performed. The attenuation test shall use a stabilized optical source and an optical power meter calibrated to the appropriate operating wavelength (1300 nm).

For each installed fiber, the power attenuation shall not exceed the following, tested from connector to connector at the respective patch panels:

$$(0.0035)\ L + (0.25)\ N + 3.0\ dB$$

Where L = The length of the fiber optic cable in meters and
N = the number of splices in the fiber.

Any fiber optic cables containing one or more fibers not meeting this performance will not be accepted by the Owner, and shall be repaired or replaced at no additional cost.

Each fiber optic jumper cable shall be tested and must exhibit an end-to-end attenuation of less than 2.0 dB at 1300 nm. Any jumper exceeding this level shall be replaced at no additional cost to the owner. Any damaged cable still on the reel shall be returned to the manufacturer for replacement at no additional cost to the Owner.

All fiber cable testing shall be documented on pre-approved test forms. Three (3) copies of all documentation (including OTDR traces) shall be submitted to the Engineer upon successful completion of the testing.

End of Section