Technical Specifications

for

Spalding County PDB Services for 2024 Sewer Implementation

Spalding County, Georgia

Spalding County Water Authority
119 E Solomon St, Griffin, GA 30223

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ISSUED FOR CONSTRUCTION
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NOT USED

SECTION 01001
SUMMARY OF WORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Definition: The Work is defined as the construction of a new sewer system for the Arthur K. Bolton overlay district in Spalding County, Georgia. The principal components include new gravity sewer, one lift station, force main and a new 200,000 gpd water resources facility.

B. Alternatives: None

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

1. A gravity sewer system with approximately 10,000 linear feet (LF) of 16-inch diameter PVC C900 DR 25 piping. Approximately 34 manholes will be installed with pipe cover ranging from 15 to 25 feet. The gravity system would terminate at a proposed lift station near Wani Road.
2. A submersible type lift station, the Wani Road Lift Station, equipped with duplex submersible solids-handling pumps and convey flow to the Water Reclamation Facility (WRF). The lift station design will include a precast manhole wet well and a valve vault.
3. The lift station force main is approximately 2,240 LF of 8-inch diameter HDPE DR 9 pipe, terminating at the WRF headworks.
4. A 200,000 gpd rated capacity WRF constructed of factory-built above-grade steel tanks. The treatment technology will be activated sludge type as pre-engineered and provided by Southwest Fluid Products Inc and in accordance with performance criteria stipulated in Section 11500. The major components include:
    a. Grading and related site work for the new WRF.
    b. Headworks with manual and mechanical screens.
    c. Aeration basins with coarse bubble diffused aeration.
    d. Swing Basin and Aerobic Digester also with coarse bubble diffused aeration.
    e. Secondary clarifiers.
    f. Chlorine contact tank.
    g. Chemical feed systems.
    h. Air blowers.
    i. Solids dewatering equipment.
    j. Operations Building and garage.
    k. Water well and potable and non-potable water systems.
    l. Primary and secondary (engine driven generator) electrical

power systems.
m. Instrumentation and control systems.
n. Gravity outfall to Cabin Creek.

PART 2 – PRODUCTS – (Not Used)

PART 3 – EXECUTION – (Not Used)

+++ END OF SECTION 01001 +++

SECTION 01010
PROJECT PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

Section includes:

A. Lands and Rights-of-Way/Easements, and Permits

B. Access to and **Contractor's** use of the site

C. Coordination requirements

D. Construction procedures

1.02 LANDS AND RIGHTS-OF-WAY: EASEMENTS AND PERMITS

A. Access to the Work shall be limited to the right-of-way or easement area provided for execution of the Work. The **Contractor** shall not enter any adjacent private property without prior written approval from the property owner. Proof of such approval shall be furnished to the **Owner** upon request. If the **Contractor** deems additional permitting and access are required then they shall be obtained by the **Contractor** and the **Contractor** shall bear the cost.

B. If the **Contractor** performs any work or service for any property owner outside the specified scope of the **Contractor's** agreement with the **Owner** or has any agreements with a private property owner for access to or for temporary use of property outside of the right-of-way or easement area, a written agreement shall be entered into with the private property owner(s) prior to any work or service being performed or prior to any use by **Contractor** of the private property and such agreement shall be provided to the **Owner**. The agreement shall contain the following language, in addition to the terms agreed to between the **Contractor** and the property owner:

> "The Property Owner understands that Owner is not a party to this Agreement, exercises no control over the means, methods, and execution of this agreement, and that Owner assumes no responsibility for the Contractor's compliance with the terms of this agreement. The Contractor shall be solely liable for any and all claims, demands, and judgments related to loss or damage to property or person (including death) arising from or in any way related to the Contractor's acts or omissions related to the agreement."

1.03 ACCESS TO AND CONTRACTOR'S USE OF THE SITE

A. The space available to the **Contractor** for the performance of the Work, either exclusively or in conjunction with others performing other construction as part of the project, is shown on the drawings.

B. Equipment and vehicles used by the **Contractor** on the project shall be marked with the **Contractor's** name and telephone number.

1.04 COORDINATION REQUIREMENTS

A. Coordination with **Owner**:

1. Limit access through occupied areas to those days and times the **Owner** approves. Occupied areas include areas in which the **Owner's** regular operations will be going on or to which the **Owner** requires access during the construction period.

2. When the following must be modified, provide alternate facilities acceptable to the **Owner**:

   a. Emergency means of egress

   b. Utilities that must remain in operation

   c. Informational signage

3. The **Contractor** shall notify the **Owner** immediately of any circumstances that may jeopardize or that have interrupted utility service.

B. Security Procedures:

1. Limit access to the site to persons involved in the Work.

2. Provide secure storage for materials.

3. Secure completed work as required to prevent loss.

C. Coordination of Construction:

1. Inform each party involved, in writing, of procedures required for coordination of the Work; include requirements for giving notice, submitting reports, and attending meetings.

2. Inform the **Owner** in advance, 45 days prior to start, when coordination of Work is required.

D. Utilities Notification Prior to Construction:

1. Georgia law mandates that, before beginning mechanical digging or excavation work, **Contractor** shall contact Georgia 811 by using eRequest on www.Georgia811.com or by calling 811 or 1-800-282-7411.

2. **Contractor** may utilize EDEN (Excavation Digging Event Notification) web application that enables Members and Professional Excavators to create, manage, respond to, and edit Georgia 811 Locate Request Tickets.

3. **Contractor** shall retain records of notification and responses during the course of the project until final Payment.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 CONSTRUCTION

A. General Examination Requirements:

1. Prior to performing work, examine the applicable substrates and the conditions under which the work is to be performed.

2. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding.

3. Notify the **Owner** promptly of type modifications required.

4. Before starting work that might affect existing construction, verify the existence and location of underground utilities and other underground construction.

5. Prepare preconstruction photographic documentation in conformance with the requirements of **Section 01380 - Photographic Documentation** of these specifications.

B. General Preparation Requirements:

1. The **Contractor** shall obtain, maintain, and pay for required permits.

2. The **Contractor** shall take field measurements as required to properly conduct the work.

C. Cleaning and Protection: Keep installed work clean, and clean again when soiled by other operations.

D. Final Cleaning:

1. Remove materials and equipment that are not part of the work and any debris from the site prior to substantial completion.

2. Dispose of debris in a lawful manner.

3. Perform final cleaning after substantial completion has been certified, but before final payment.

4. Clean entire project site and grounds.

E. Substantial Completion:

1. Requirements for the **Contractor** achieving Substantial Completion are defined in the Contract Documents in the General Requirements.

2. When the **Contractor** believes Substantial Completion has been achieved, **Contractor** shall notify the **Owner** in writing, requesting Substantial Completion. The **Owner** will verify that the contractual documentation requirements for Substantial Completion have been completed.If verified, the **Owner** will schedule a Substantial Completion inspection and walk-through with the **Contracto**r, **Owner**, and the Engineer.

F. Final Completion:

1. Requirements for the **Contractor** achieving Final Completion are defined in the Contract Documents.

3.02 HEALTH AND SAFETY CONSIDERATIONS

A. Take precautions to prevent fires and to facilitate firefighting operations.

B. Take precautions to prevent accidents due to physical hazards.

C. Maintain working conditions in order to keep the site and adjacent public ways free of hazardous and unsanitary conditions and public nuisances.

D. Maintain working conditions to control rodents and other pests; prevent infestation of adjacent sites and buildings due to pests on this site.

E. Keep public streets free of debris from this Work.

F. Provide adequate traffic control in accordance with current MUTCD standards and the approved traffic permit.

G. When using trenches/excavations, follow OSHA standards 29 CFR 1926.650, 29CFR 1926.651, and 29 CFR 1926.652.

3.03 ENVIRONMENTAL PROTECTION

A. General:

Contractor shall conduct its operation in a manner to prevent pollution of the environment surrounding the area of work and shall be responsible for furnishing necessary items for fulfilling the work described herein.

B. Material Transport:

Contractor shall comply with the Official Code County of Spalding Georgia pertaining to the duties of the **Contractor** in hauling material over **Owner**-owned rights-of-way. This includes, but is not limited to, approval of proposed haul routes, prevention of dropping of materials or debris on the streets from trucks arriving and leaving the site, providing a suitable vehicle inspection and cleaning installation with permanent crew, and the removal of material spilled in public areas at no additional cost to the local government agency.

C. Waste Materials:

No waste or erosion materials shall enter natural or manmade water, wastewater collection systems, or stormwater drains. Erosion materials from excavations, borrow areas, or stockpiled fill shall be contained within the work area. **Contractor** shall develop methods for control of waste and erosion, which shall include filtration, settlement, and manual removal to satisfy the above requirements.

D. Burning:

No burning of waste shall be allowed.

E. Dust Control:

The **Contractor** shall control the generation of dust by its operations. Control of dust shall be accomplished by water sprinkling or by other methods approved by the Owner.

F. Noise Control:

The **Contractor** shall minimize the noise caused by its operations.

When required by agencies having jurisdiction, noise-producing work shall be performed in less sensitive hours of the day or week as directed by the

Owner.

G. Use of Chemicals:

Chemicals used during construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall show approval of either EPA or FDA. Use of such chemicals and disposal of residues shall be in conformance with instructions.

H. Responsibility for Spills and Accidental Discharges

In the event the **Contractor** causes or has a spill or accidental discharge for which the **Owner** is fined by the State of Georgia Department of Natural Resources Environmental Protection Division (EPD), the **Contractor** agrees to remediate the spill or discharge immediately in accordance with current EPD regulations and to pay fines assessed against the **Owner** and/or **Contractor**, and pay for the **Owner**'**s** cost associated with efforts to remediate the situation. The **Owner** shall be notified immediately of such an event.

3.04 PROTECTION OF THE WORK

A. Conduct construction operations so no part of the Work is subjected to damaging operations or influences that are in excess of those to be expected during normal occupancy conditions.

B. Execute work and stockpile spoils and materials to prevent flooding of excavations, below grade construction, and adjacent properties due to rainwater runoff.

C. Protect existing property not indicated to be removed.

D. Provide temporary supports as required to prevent movement and structural failure as designed by a Registered Professional Engineer in the state of Georgia at the Contractor's cost.

E. Equipment and vehicles used on the **Owner's** projects shall be clearly marked with the **Contractor's** name and telephone number. The identifying markings may be in the form of magnetic signs, decals, or painted lettering and shall be located on both sides of the equipment/vehicle. The lettering shall be legible, of a contrasting color to the background surface, and at least two inches in height. Markings shall be in place upon initiation of the work on the project site.

F. A copy of the Project Notice to Proceed letter issued by the **Owner** shall be available on the job site as proof of the contractual relationship of the **Contractor** with the **Owner**. The letter shall be presented for review upon

request by regulatory agencies or other **Owner** departments that visit the job site.

G. The **Contractor** shall always maintain copies of permits and approved plans on the project site.

+++ END OF SECTION +++

SECTION 01045
CUTTING AND PATCHING

PART 1 GENERAL

1.01 DEFINITIONS

A. 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.

1. 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.

2. 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".

3. "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.

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

1. 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.

1.02 SECTION INCLUDES

A. This Section specifies administrative and procedural requirements for cutting and patching.

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

1. 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.

1.03 RELATED SECTIONS

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

B. Demolition of selected portions of the building for alterations is included in Section "Selective Demolition".

1.04 QUALITY ASSURANCE

A. 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.

1. 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.

B. 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.

C. 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.

1. 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.

D. Before cutting and patching the following categories of work, obtain approval to proceed.
   1. Structural steel.
   2. Miscellaneous structural metals, including lintels, equipment supports, 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.

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

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

1.05 SUBMITTALS

A. 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:

1. 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.
2. List products to be used and firms including their qualifications that will perform work.
3. Give dates when work is expected to be performed.
4. 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.
5. 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.
6. 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.

1.06 WARRANTY

A. 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

2.01 MATERIALS

A. 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.

1. 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.

B. 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

3.01 EXAMINATION

A. 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.

B. 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.

1. 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

3.02 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. 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.

C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. 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.

3.03 PERFORMANCE

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

B. 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.

C. 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.

1. 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.
2. To avoid marring existing finish surfaces, cut the exposed or finished side into concealed surfaces.
3. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.
4. Comply with requirements of applicable Sections or Division 2 where cutting and patching require excavating and backfilling.
5. 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.

D. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.

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

2. 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.

3. 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.

a. 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.

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

3.04 CLEANING

A. 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.

B. Do not permit traffic over unprotected floor surface.

+ + + END OF SECTION + + +

SECTION 01055
CONSTRUCTION STAKING

Part 1 GENERAL

1.01 SCOPE

A. Construction staking shall include all of the surveying work required to layout the Work and control the location of the finished Project. The Contractor shall have the full responsibility for constructing the Project to the correct horizontal and vertical alignment, as shown on the Drawings, as specified, or as ordered by the Engineer.

B. The Contractor shall be responsible for the development and implementation of a surveying program capable of satisfying all Project survey and accuracy requirements. This program shall be subject to the review of the Engineer before commencement of the work. The review shall in no way release the Contractor of liabilities associated with or dependent on this part of the Services.

C. The Contractor shall assume all costs associated with rectifying work constructed in the wrong location.

D. Work under this Section also includes surveying work required to prepare Record Drawings as specified herein.

1.02 QUALITY ASSURANCE

A. The Contractor shall hire, at the Contractor's own expense, a Surveyor with current registration in the State of Georgia and shall be conducted by personnel with documented experience in the specific types of work required. The surveyor must be acceptable to the Owner, to provide project construction staking and confirmation of the vertical and horizontal alignment.

B. Any deviations from the Drawings shall be confirmed by the Engineer if it falls within the compatible tolerance prior to construction of that portion of the Project.

1.03 SUBMITTALS

A. Submit name and address of Registered Surveyor along with proof of credentials and experience in similarly scaled projects to the Engineer.

B. Submit detailed description of proposed survey method, network diagrams and equipment type, accompanied with manufacturer's literature specifying

probable accessories, calibration procedures and certificates/logs, requirements and frequencies. On request of Engineer, submit documentation to verify accuracy of construction staking.

C. Submit record drawings in accordance with **PART 3** of the Section.

1.04 EQUIPMENT CALIBRATION AND DATA ACCURATE PROCESSING

A. Calibrate all instruments as per manufacturer's recommendation and keep a log of calibration performance indicating time and individual who performed the calibration.

B. Data processing shall include, as required, rigorous least squares adjustments. Employ data outlier detection. Determine horizontal and vertical confidence intervals.

1.05 COMPLIANCE WITH CONTRACTOR'S OFFERED FIELD ENGINEERING SERVICES

A. Report to the engineer any loss or destruction of any of the survey control points. In addition, any discovered discrepancy related to the control points established by the engineer, the latter must be informed within forty-eight (48) hours of the discovery and before starting the work.

B. Establish, verify and maintain a minimum of three (3) additional survey monuments for the work at each work site. The monuments shall be permanent on site and referenced to the established survey control points. Record locations, with horizontal and vertical data, on Project Record Documents. Monuments will also be checked and verified by the construction verification surveyor. Survey notes relating to the monuments and primary control points shall be submitted to the Engineer.

C. Establish elevations, lines and levels. Locate and layout by instrumentation and similar appropriate means:

1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes and invert elevations.

2. Grid or axis for structures.

3. Foundation and wall locations, sloping floor elevations, and embedment centerlines and elevations.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 PROJECT CONDITIONS

A. The Drawings provide the location of principal components of the Project. The Engineer may order changes to the location of some of the components of the Project or provide clarification to questions regarding the correct alignment.

B. The Engineer will provide the following:

1. One vertical control point on the Project site with its elevation shown on the Drawings.

2. A minimum of two horizontal control points on the Project site with their coordinates shown on the Drawings.

3.02 GENERAL

A. From the information shown on the Drawings and the information to be provided as indicated in paragraph 3.01 above, the Contractor shall:

1. Be responsible for establishing GPS control coordinate control system, setting reference points and/or offsets, establishment of baselines, and all other layout, staking, and all other surveying required for the construction of the Project.

2. The horizontal position of all points shall be referenced to the North American datum of 1983 (1986 adjustment) in the Georgia State Plane West 1002 Coordinate System.

3. The vertical position of all points shall be referenced to the North American Vertical datum of 1988.

4. All coordinate values shall be delivered as grid coordinates in US Survey Feet.

5. The minimum data accuracy required for all record drawings shall be +/- 0.10 USFT (one tenth of one foot).

6. Safeguard all reference points, stakes, grade marks, horizontal and vertical control points, and shall bear the cost of re-establishing same if disturbed.

7. Stake out the limits of construction to ensure that the Work does not deviate from the indicated limits.

8. Stake out the pipeline horizontal and vertical alignment.

9. Be responsible for all damage done to reference points, baselines, center lines and temporary bench marks, and shall be responsible for the cost of re-establishment of reference points, baselines, center lines and temporary bench marks as a result of the operations.

10. Maintain a complete, accurate log of all control and survey work as it progresses.

B. Baselines shall be defined as the line to which the location of the Work is referenced, i.e., edge of pavement, road centerline, property line, right-of-way or survey line.

3.03 STAKING PRECISION

A. The precision of construction staking shall match the precision of components location indicated on the Drawings. Staking of utilities shall be done in accordance with standard accepted practice for the type of utility.

B. The precision of construction staking required shall be such that the location of the water main or sewer or storm drain can be established for construction and verified by the Engineer. Where the location of components of the water main or sewer or storm drain, (i.e. fittings, valves, manholes, road crossings, etc.) are not dimensioned, the establishment of the location of these components shall be based upon scaling these locations from the Drawings with relation to readily identifiable land marks, i.e. survey reference points, power poles, manholes etc.

C. Paved Surfaces: The Contractor shall establish a reference point for establishing and verifying the paving subgrade and finished grade elevations. Any variance with grades shown on the Drawings shall be identified by the Contractor and confirmed by the Engineer prior to constructing the base.

3.04 RECORD DRAWINGS

A. Water Mains

1. The Contractor shall submit record drawings which show the final installed location of the water main and survey data for all installed pipe, valves and fittings, tunnel and casing limits and service connections 3-inches in diameter and greater. Survey data shall consist of final coordinates for all valves, fittings, tunnel and casing limits and main tap locations for service connections 3-inches in diameter and greater and center line of pipe at points every 500 feet

along the length of pipe installed.

2. In addition, the location of all valves and fittings and main tap location for service connections 3-inches in diameter and greater shall be indicated by at least 2 ties (measured distances) from permanent fixed objects within the public right of way, as accepted by the Engineer, to allow the Owner to locate the water main and components in the future without the use of GPS instruments.

B. Sewers and Storm Drains

1. The Contractor shall submit record drawings which show the final installed location of storm and sanitary pipes and structures. The information shall include coordination, pipe and structure size and type, rim elevations, and inverts of each influent and effluent line.

2. Record drawing information provided shall include pipe sizes, slope percentage, and materials. Lateral tie-ins and alignments to the served facilities shall also be included.

C. The record drawings shall also indicate the horizontal and vertical location, dimensions and materials of all utilities encountered during excavation.

D. Record drawings must be georeferenced to the U.S. State Plane Coordinate System, NAD 83 GA West Zone, US Survey Feet. All drawings must contain two reference pins which are labeled and tied to the Spalding County GPS Monument Network.

E. Two full size hard copies of record drawings shall be furnished to the Engineer for review. Each record drawing shall be stamped with the name of the Contractor, signed and dated by the Contractor's Project Manager and signed, sealed and dated by the Surveyor. Record Drawings, once approved by the Engineer, shall be scanned and saved as PDF's.

F. The Contractor shall provide an electronic copy of the record drawings in AutoCAD Civil 3D 2015 (.DWG) format.

G. Final submittal of record drawings shall be provided by two compact disks containing the signed and sealed PDF's and DWG files referenced above.

+++ END OF SECTION +++

SECTION 01060
REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

A. Permits and Responsibilities: The Contractor shall, without additional expense to the **Owner**, 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.

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

C. 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.

1.02 NPDES PERMITS FOR STORM WATER DISCHARGES

A. 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.

B. 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).

C. 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;

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

E. 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 01060 +++

SECTION 01300
SUBMITTALS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Preparing and processing of submittals for review and action.

2. Preparing and processing of informational submittals.

B. Submit the following for the Engineer and/or **Owner's** review and action:

1. Shop drawings

2. Product data

3. Samples

4. Submittals indicated as "for approval"

C. Submit the following as informational submittals:

1. Structural design information required by the contract documents

2. Certificates

3. Coordination drawings

4. Reports

5. Qualification statements for manufacturers/installers

6. Submittals indicated as "for information only"

D. Specific submittals are described in individual sections.

E. Do not commence Work that requires review of any submittals until receipt of returned submittals with an acceptable action.

F. Do not allow submittals without an acceptable action marking to be used for the project.

G. Submittals shall be submitted to the **Owner** using the **Contractor's** Document Tracking and Control System (DTCS). No email submittals shall be allowed for approval. One copy of each submittal shall be uploaded by the **Contractor** into the software program named by the **Owner**. The **Owner** may determine that certain submittals also shall be submitted in hard copy form.

1.02 DEFINITIONS

A. "Shop drawings" are drawings and other data prepared by the entity that is to do the Work, specifically to show a portion of the Work.

B. "Product data submittals" are standard printed data that show or otherwise describe a product or system, or some other portion of the Work.

C. "Samples" are actual examples of the products or Work to be installed.

D. "Informational submittals" are those identified in the Contract Documents as for information only.

1.03 FORM OF SUBMITTALS

A. Submittals shall be uploaded to the DTCS in PDF format unless otherwise specified by the **Owner or Engineer**.

1. Samples:

   a. Two sets of each shall be submitted with the original submittal.

   b. One set shall be returned.

   c. If additional sets are needed by other entities involved in Work represented by the samples, these shall be submitted with original submittal.

1.04 COORDINATION OF SUBMITTALS

A. Coordinate submittals and activities that shall be performed in sequence or of different types for the same product or system so that the **Owner and/or Engineer** has enough information to properly review each submittal.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 TIMING OF SUBMITTALS

A. Transmit each submittal at the time indicated on the approved construction schedule.

B. Deliver each submittal requiring approval in time to allow for adequate review and processing time, including resubmittals if necessary; failure of the **Contractor** in this respect shall not be considered as grounds for an extension of the contract time.

C. Deliver each informational submittal prior to start of the Work involved, unless the submittal is of a type that cannot be prepared until after completion of the Work; submit promptly.

D. If a submittal must be processed within a certain time in order to maintain the progress of the Work, state so clearly on the submittal.

E. If a submittal must be delayed for coordination with other submittals not yet submitted, the **Owner** may, at its option, either return the submittal with no action or notify the **Contractor** of the other submittals that shall be received before the submittal can be reviewed.

3.02 SUBMITTAL PROCEDURES – GENERAL

A. **Contractor** review: Sign each copy of each submittal certifying compliance with the requirements of the contract documents.

B. Notify the **Owner**, in writing and at time of submittal, of points upon which the submittal does not conform to the requirements of the contract documents, if any.

C. Preparation of submittals:

1. Label each copy of each submittal with the following information:

    a. Project name

    b. Date of submittal

c. **Contractor's** name and address

d. Supplier's name and address

e. Manufacturer's name

f. Specification section where the submittal is specified

g. Numbers of applicable drawings and details

h. Other necessary identifying information

2. Submittals to receive **Owner's** action marking: Provide blank space on the label or on the submittal itself for action marking: minimum 4 inches wide by 5 inches high.

D. Transmittal of submittals:

1. Submittals shall be accepted from the **Contractor** only.

2. Submittals received without a transmittal form shall be returned without review or action.

3. Transmittal form: The **Contractor** shall use a form with space provided on the form for:

a. Project name

b. Submittal date

c. Transmittal number

d. Specification section number

e. To:

f. From:

g. **Contractor**'s name

h. Subcontractor's and supplier's names

i. Manufacturer's name

j. Submittal type (shop drawing, product data, sample, informational submittal)

k. Description of submittal

l. Action marking

m. Comments

4. The **Contractor** shall complete a separate transmittal form for each submittal, also including the following:

a) Other relevant information

b) Requests for additional information

3.03 SHOP DRAWINGS

A. Content: Include the following information:

1. Dimensions, at accurate scale

2. All field measurements that have been taken, at accurate scale

3. Names of specific products and materials used

4. Details, identified by contract document sheet and detail numbers

5. Compliance with the specific standards referenced

6. Coordination requirements, including the relationship to adjacent or critical work

7. Name of preparing firm

8. Design calculations

B. Preparation:

1. Reproductions of contract documents are not acceptable as shop drawings.

2. Copies of standard printed documents are not acceptable as shop drawings.

3. Documents shall be identified as indicated for submittals.

4. Space for **Owner's** action marking shall be adjacent to the title block.

3.04 PRODUCT DATA

A. Submit product data submittals for each system or unit of Work as one submittal.

B. When product data submittals are prepared specifically for this Project (in the absence of standard printed information), submit such information as shop drawings, and not as product data submittals.

C. Content:

1. Submit manufacturer's standard printed data sheets.

2. Identify the particular product being submitted; submit only pertinent pages.

3. Show compliance with properties specified.

4. Identify which options and accessories are applicable.

5. Include recommendations for application and use.

6. Show compliance with the specific standards referenced.

7. Show compliance with specified testing agency listings; show the limitations of their labels or seals, if any.

8. Identify dimensions, which have been verified by field measurement.

9. Show special coordination requirements for the product.

3.05 SAMPLES

A. Samples:

1. Provide samples that are the same as the proposed product.

2. Where selection is required, provide the full set of options.

B. Preparation:

1. Attach a description to each sample.

2. Attach name of manufacturer or source to each sample.

3. Where compliance with specified properties is required, attach documentation showing compliance.

4. Where there are limitations in availability, deliveries, or other similar characteristics, attach descriptions of such limitations.

5. Where selection is required, the first submittal may be a single set of options; after return of submittal with selection indicated, submit standard number of sets of selected item.

C. Keep final sample set(s) at the Project Site, available for use during progress of the Work.

3.06 REVIEW OF SUBMITTALS

A. Submittals for approval shall be reviewed, marked with appropriate action, and returned. Submittals are reviewed for conformance with project design concept and for compliance with standard of quality established in the Contract Documents. This review shall not relieve the **Contractor** from responsibilities for correctness of detail and dimension, nor from deviation from Contract Document requirements, except as noted and accepted in writing by the **Engineer** at the time of submittal.

B. Informational submittals shall be reviewed.

C. Action markings for submittals for approval shall be as follows:

1. NO EXCEPTIONS TAKEN (NET): Indicate that the submitted item is released for manufacture.

2. MAKE CORRECTIONS NOTED (MCN): Indicate that the submitted item is

released for manufacture with the submittal complying with the comments.

3. AMEND AND RESUBMIT (AAR): Indicates that the submittal shall be revised or a new submittal complying with the comments made shall be prepared.

4. REJECTED (REJ): Indicates that the submitted item does not comply with contract requirements and that another selection shall be made, and the submittal process repeated.

5. SUBMIT SPECIFIED ITEM(s) (SSI): Indicates that the submittal shall submit specified item(s) based on the specifications or as stated by the **Engineer.**

3.07 RETURN, RESUBMITTAL, AND DISTRIBUTION

A. Submittals shall be returned to the **Contractor** through the DTCS.

B. The **Contractor** shall address resubmittals in the same manner as original submittals, with changes other than those requested by the **Owner or Engineer,** clearly indicated.

1. Exception: Transmittal number for resubmittal shall be the number of the original submittal plus a letter suffix.

2. Resubmittals shall be submitted within 14 days of **Contractor's** receipt of rejected submittal.

C. Distribution: The **Contractor** shall make one copy for project record documents and file in the DTCS.

+++ END OF SECTION 01300 +++

SECTION 01380

PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

The **Contractor** shall clearly document site conditions along the entire project site prior to the start and upon the completion of the project/contract by use of digital video recording. The cost of the photographic documentation shall be included in the Contract Price.

The **Contractor** shall submit monthly color progress photos of the active Work sites. Monthly record progress photographs shall be submitted with monthly payment requisition. Photographs shall document construction within roadways, rights-of-way, and easements, and at the Wani LS and Water Resources Facility (WRF) Site.

1.02 PROCEDURES

A. The digital video recording and periodic still photographs shall be taken from identifiable reference points within the Work sites. The same reference points shall be used through the life of the project/contract to achieve an accurate record of construction.

B. The **Contractor** shall adequately document areas of sensitivity such as landscaped areas, lake or stream banks, or areas surrounding existing structures.

C. Each photograph, video, or digital file of such submitted shall be dated.

D. Recording shall be done with adequate lighting. Written authorization by the **Owner** to proceed with video documentation at any areas shall be done with consideration of existing environmental conditions.

E. The daily construction photographs shall be the permanent visual record of the pre-construction conditions, daily construction site activities, and the completion of construction Work.

1.03 VIDEOS

A. The project corridor shall be documented by digital video recordings.

B. All digital video recordings shall be in color and shot with a 1080 HD (1920 x 1080) using MPEG-4 program stream encoding (ISO-IEC 14496-14) camera and shall be a clear, stable image with no interference. Black and white recordings shall not be accepted. The video shall be provided on Digital Video Discs (DVDs) or USB Flash Drives and shall conform to currently recognized standards for video recordings. Specifically, the recordings shall be in focus and properly illuminated with good

contrast. The picture shall be clear and possess accurate color levels and balance (tint) without outside interference. All recordings shall also include a clear and distortion free audio narration that clearly identifies all, important features of the project, including stationing along pipeline construction, and is in synchronization with the video. The recording shall bear a continuous "date and time stamp" that is electronically recorded by the camera.

C. A record of the contents of each recording shall be provided on a run sheet, identifying each chapter segment of the recording. The run sheet shall be provided in paper copy as well as on the flash dive or hard drive.

1.04 PHOTOGRAPHS

A. The file format for digital photographs shall be Tagged Image File Format (TIFF).

B. Digital cameras shall produce records with true optical resolution. Images shall not be resized or interpolated to a higher resolution from a lower resolution.

C. Photographic images shall be provided as 8 bit per channel RGB color images.

D. Digital camera files shall be captured as 12 megapixel files or greater in size with a minimum pixel array of 5,000 pixels by 3,500 pixels.

E. Digital images shall be furnished via an online location accessible to **OWNER**. All online file folders shall have a label that includes project information as well as the date, work location (i.e. Gravity Sewer, Force Main, Wani Road LS, WRF, etc) and whether these are pre-construction, construction, or post-construction photographs.

1.05 SUBMITTALS

A. The **Contractor** shall furnish to the **Owner** for approval one copy of the video digital file taken of existing conditions prior to start of the Project and before the submittal of the first request for payment. The video digital file shall be assembled upon completion of the Project and shall be furnished to the **Owner** for approval prior to submittal of the final request for payment. No pay requests shall be processed before the submittal of the respective video records.

B. **Contractor** shall utilize **Owner's** Project Document Tracking and Control System to submit videos and progress photographs in electronic format for the duration of the project in accordance with **Section 01350 - Project Document Tracking and Control Systems**.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 USE OF PHOTOGRAPHS AND VIDEOS

A. Upon their creation, the photographs, prints, DVDs, and videos resulting from the Work under this Contract shall become the exclusive property of the **Owner**.

B. Neither the **Contractor** nor the photographer nor the video recording firm shall retain any rights pertaining to the photographs, prints, CDs/DVDs, or videos, nor shall they reproduce or otherwise publish or disseminate any of the photographs, aerials, prints, CDs/DVDs, or videos taken under this Contract without the prior written approval of the **Owner**.

C. The photographs, prints, CDs/DVDs, and videos shall be considered "Work made for hire" under applicable provisions of the Copyright Act, and the **Owner** shall be the copyright owner thereof and of the aspects, elements, and components thereof in which copyright protection might subsist. To the extent that such materials do not qualify as "Work made for hire," the **Contractor** hereby irrevocably transfers, assigns, and conveys exclusive copyright ownership in and to such materials to the **Owner**, free and clear of any liens, claims, or other encumbrances. The agreements between the **Contractor** and the photographer and videotaping firm shall include a provision containing these requirements.

END OF SECTION

SECTION 01400
QUALITY ASSURANCE/QUALITY CONTROL

PART 1 GENERAL

1.01 SCOPE

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

B. (Not Used)

1.02 SITE INVESTIGATION AND CONTROL

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

B. **Contractor** shall inspect related and appurtenant Work and report in writing to the **Owner** any conditions that will prevent proper completion of the Work. Failure to report any 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 **Contractor**'s expense.

1.03 INSPECTION OF THE WORK

A. All work performed by the **Contractor** and subcontractors shall be inspected by the **Contractor** and non-conforming Work and any safety hazards in the work area shall be noted and promptly corrected. The **Contractor** is responsible for the Work to be performed safely and in conformance to the Contract Documents.

B. The Work shall be conducted under the general observation of the **Owner** 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 Contract Documents. Such inspection may include mill, plant, shop, or field inspection, as required. The **Owner** or any inspector(s) shall be permitted access to all parts of the Work, including plants where materials or equipment are manufactured or fabricated.

C. The presence of the **Owner**, or any inspector(s), however, shall not relieve the **Contractor** of the responsibility for the proper execution of the Work in

accordance with all requirements of the Contract Documents. Compliance is the responsibility of the **Contractor**. No act or omission on the part of the **Owner**, or any inspector(s) shall be construed as relieving **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. The **Owner** may accept non-conforming Work when adequate compensation is offered and it is in the **Owner**'s best interest as determined by the **Owner**.

D. All materials and articles furnished by the **Contractor** or subcontractors 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 **Owner** or other designated representative. No Work shall be backfilled, buried, cast in concrete, covered, or otherwise hidden until it has been inspected. 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.

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

1.04 TIME OF INSPECTION AND TESTS

A. Samples and test specimens 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 **Contractor**'s own expense.

B. Whenever the **Contractor** is ready to backfill, bury, cast in concrete, hide, or otherwise cover any Work under this Contract, the **Owner** shall be notified not less than three work days in advance to request inspection before beginning any such Work of covering. Failure of the **Contractor** to notify the **Owner** at least three work days in advance of any such inspections shall be reasonable cause for the **Owner** 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**.

1.05 SAMPLING AND TESTING

A. The **Contractor** shall retain and pay for an independent materials testing agency approved by the **Owner** as required by the General Conditions. This 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 **Owner** reserves the right to use any generally accepted system of inspection which, in the opinion of the **Owner**, will ensure the **Owner** that the quality of the workmanship is in full accord with the Contract Documents.

B. The **Owner** reserves the right to abbreviate, modify the frequency of or waive tests or quality assurance measures, but waiver of any specific testing or other quality assurance measure, 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, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial work, shall not be construed as a waiver of any technical or qualitative requirements of the Contract Documents.

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

D. In addition to any other inspection or quality assurance provisions that may be specified, the **Owner** shall have the right to independently select, 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 provided that wherever any portion of the Work is discovered, as a result of such independent testing or investigation by the **Owner**, which fails to meet the requirements of the Contract 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**.

1.06 CONTRACTOR'S QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

A. 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 the **Contractor**'s personnel and subcontractors (including fabricators and suppliers). This program shall be described in a Plan responsive to this Section. It shall utilize the services of an independent testing agency/company that is industry certified to provide quality assurance and compliance with the standards specified.

B. The **Contractor** shall furnish the **Owner** a project specific QA/QC Plan. The Plan shall contain a comprehensive account of **Contractor**'s QA/QC procedures as applicable to this job. The **Contractor** shall furnish for review by the **Owner**, no later than 14 days after receipt of notice to proceed, the QA/QC plan proposed to be implemented. The 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 Plan are delineated in the following paragraphs. No payments will be made to the **Contractor** until the QA/QC Plan is fully accepted by the **Owner**.

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

1. The QA/QC Manager shall be as identified by the **Contractor** and approved by the **Owner**. The QA/QC Manager shall have a minimum of five (5) years of construction experience in pipe line installation. The QA/QC Manager shall be onsite at all times while work is being performed by the **Contractor**, to remedy and demonstrate that work is being performed properly and to make multiple observations of all Work in progress. This individual shall be dedicated solely to QA/QC activities and shall have no supervisory or managerial responsibility over the work force. The QA/QC Manager shall not be assigned any other duties or roles by the **Contractor**.

2. The **Contractor** shall provide additional personnel who are assigned to assist the QA/QC Manager as required to fulfill the requirements of the QA/QC Plan. The **Contractor** shall provide a copy of the letter to the QA/QC Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the QA/QC Manager, including authority 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**.

D. The **Contractor**'s QA/QC program shall ensure the achievement of adequate quality throughout all applicable areas of the Project. A customized QA/QC Plan shall be developed that discusses each type of work that the **Contractor** is responsible for within the Project. The QA/QC Plan shall describe the program and include procedures, work instructions and records and a description of the quality control organization.

1. 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 resume format), duties, responsibilities, and authorities of each person assigned a QA/QC function including the QA/QC Manager.

2. In addition, the Plan shall describe methods relating to areas that require special testing and procedures as noted in the specifications.

E. 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.

F. The procedures shall provide for proper identification and storage, and prevent the use of incorrect or defective materials.

G. 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.

1. 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 **Owner** for review and approval.

2. The **Contractor** shall maintain and provide to the **Owner**, 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.

3. Procedures shall include:

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

    b. Maintaining and providing daily QA/QC inspection reports. Such reports shall, at a minimum, include the following:

        i. Dated list of Item(s) inspected

        ii. Location of the test sample(s)

        iii. Logs, detailed locational drawings and confirmation reports

        iv. Quality characteristics in compliance

        v. Quality characteristics not in compliance

        vi. Corrective/remedial actions taken

        vii. Statement of certification

        viii. QC Manager's signature

    c. 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.

    d. Procedures to preclude the covering of deficient or rejected Work.

    e. Procedures for halting or rejecting Work.

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

    g. Method of documenting QA/QC process and results including:

        i. Automatic exception reporting

        ii. Resolution tracking

        iii. Quality Confirmation Test reports

        iv. Sample retention index and storage

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

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

    a. Individual test records containing the following information:

        i. Item tested –item number and description

        ii. Test results

        iii. Test designation

        iv. Test work sheet including location sample was obtained

        v. Acceptance or rejection

        vi. Date sample was obtained

        vii. Retest information, if applicable

        viii. Control requirements

        ix. Tester signature

        x. Testing QC staff initials

    b. Maintaining and providing to the **Owner** daily testing records. Such records shall, at a minimum, contain the following:

        i. Dated list of Item(s) inspected

        ii. Location of the test sample(s)

        iii. Logs, detailed location drawings and confirmation reports

        iv. Quality characteristics in compliance

        v. Quality characteristics not in compliance

        vi. Corrective/remedial actions taken

        vii. Statement of certification

c. QC Manager's signature providing for location maps/drawings (i.e. lift drawings, laying schedules, etc.) for all tests performed or location of Work covered by the tests.

d. Maintaining copies of all test results.

e. Ensuring **Owner** receives independent copy of all tests.

f. Ensuring testing lab(s) are functioning independently and in accordance with the specifications.

g. Ensuring re-tests are properly taken and documented.

H. 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.

I. 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 subcontractors and suppliers. QA/QC inspections and certifications shall not be deferred to the **Contractor**'s subcontractors or suppliers.

J. Deficient, Defective and Non-conforming Work and Corrective Action

1. The QA/QC Plan shall include procedures for handling of 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 procedures 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:

a. Personnel responsible for identifying deficient and non-complying items within the work.

b. How and by whom deficient and non-compliant items are documented “in the field”.

c. The personnel and process utilized for logging deficient and non-compliant work at the end of each day onto a Deficiency Log.

d. Tracking processes and tracking documentation for Deficient and Non-Compliant items.

e. Personnel responsible for achieving resolution of outstanding deficiencies.

f. Once resolved, how are the resolutions documented and by whom.

2. (Not Used)

K. Special Processes And Personnel Qualifications

1. 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.).

2. 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 **Owner** before the start of Work on the Project.

L. Audits

1. 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. Audit records shall be made available to the **Owner** upon request.

2. The **Contractor** shall provide to the **Owner**, a quarterly report indicating any outstanding and unresolved exceptions to the QA/QC program or contract documents. The report will include documentation on any standards modifications, corrections, failed tests and a review of field procedures and checks and balances effectiveness.

M. Documented Control/Quality Records

1. The **Contractor** shall establish methods for control of Contract 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 **Owner**.

2. 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.

3. 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.

4. The **Contractor** shall provide a list with specific records as specified in the Contract Documents which will be furnished to the **Owner** at the completion of activities and in conjunction with logs and location drawings.

N. Acceptance of QA/QC Plan: The **Owner**'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 **Owner**'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 the **Owner**'s acceptance of **Contractor**'s QA/QC plan has been obtained.

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

1.07 TESTING SERVICES

A. All tests which require the services of a laboratory to determine compliance with the Contract Documents shall be performed by an independent commercial testing firm acceptable to **Owner**. 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**.

B. 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).

C. The **Owner** 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 manual, equipment calibrations, proficiency sample performance, etc.).

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

E. Testing Services Provided by the **Contractor**

1. Unless otherwise specified, and in conjunction with, all other specified testing requirements, the **Contractor** shall provide the following testing services, and submit a detailed testing plan for each along with proposed forms for **Owner**'s review:

2. Moisture-density and relative density tests on embankment, fill, and backfill materials.

3. In-place field density test on embankments, fills and backfill.

4. QC testing of all precast and/or pre-stressed concrete

5. All other tests and engineering data required for the **Owner**'s review of materials and equipment proposed to be used in the Work

6. In addition, the following QC tests shall be performed by the **Contractor**:

    a. Holiday testing of pipeline and all other coatings systems applied to surfaces as required by the **Owner**

    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.

7. Testing, including sampling, shall be performed by the **Contractor**'s testing firm's laboratory personnel, in the manner and frequency indicated in the Specifications. The **Owner** 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 the testing firm's laboratory, in required quantities.

8. 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.

9. 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 **Owner** and shipped to the laboratory by the **Contractor** at **Contractor**'s expense.

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

F. Transmittal of Test Reports:

1. Written reports of tests and engineering data furnished by **Contractor** for **Owner**'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 will be required as a final close-out submittal for the release of retainage.

2. 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.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

+++ END OF SECTION 01400 +++

SECTION 01410
TESTING LABORATORY SERVICES

PART 1 – GENERAL

1.01 SCOPE

A. This Section includes testing which the **Engineer** may require, beyond that testing required of the manufacturer, to determine if materials provided for the Project meet the requirements of these Specifications.

B. This section also includes all testing required by the **Engineer** to verify if work performed by the **Contractor** is in accordance with the requirements of these specifications, i.e., concrete strength and slump testing, soil compaction, etc.

C. This section does not include testing required in various sections of these specifications to be performed by the manufacturer, i.e., testing of pipe. Where no testing requirements are described in various sections of these specifications, but the **Owner** decides that testing is required to demonstrate compliance with material or performance standards, the **Owner** may require testing to be performed under current pertinent standards for testing.

D. An independent testing laboratory shall be selected by the **Contractor** approved by the **Owner** and paid by the **Contractor**. The laboratory must be approved in writing by the **Owner** before any testing services are performed.

E. The **Contractor** shall pay directly for the services of the independent testing laboratory for all testing required under this Contract.

F. Employment of the testing laboratory shall in no way relieve the **Contractor** of **Contractor**'s obligation to perform work meeting the requirements of the Contract.

G. Testing laboratory services will be required for, but not be limited to:

1. Cement
2. Aggregate
3. Concrete
4. Steel and Metals
5. Welding

6. Backfill and Compaction

7. Bituminous Pavement

1.02 LABORATORY DUTIES

A. Cooperate with the **Engineer** and **Contractor**.

B. Provide qualified personnel promptly on notice.

C. Perform specified inspections, sampling and testing of materials.

1. Comply with specified standards, ASTM, other recognized authorities, and as specified.

2. Ascertain compliance with requirements of the Contract Documents.

D. Promptly notify the **Engineer** and **Contractor** of irregularity or deficiency of work which are observed during the performance of services.

E. Promptly submit three copies (two copies to the **Engineer** and one copy to the **Owner**) of report of inspections and tests in addition to those additional copies required by the **Contractor** with the following information included:

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 sample or test in the Project

10. Type of inspection or test

11. Results of test and observations regarding compliance with the Contract Documents

12. Interpretation of test results, when requested by the **Engineer** or **Owner**

F. Perform additional services as required.

G. The laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of the Contract Documents

2. Approve or accept any portion of the Work

3. Perform any duties of the **Contractor**.

1.03 CONTRACTOR RESPONSIBILITIES

A. Cooperate with laboratory personnel; provide access to Work and/or manufacturer's requirements.

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

C. Furnish copies of mill test reports.

D. Furnish required labor and facilities to:

1. Provide access to Work to be tested;

2. Obtain and handle samples at the site;

3. Facilitate inspections and tests;

4. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.

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

F. Laboratory Tests: Where such inspection and testing are to be conducted by an independent laboratory agency, the sample(s) shall be selected by such laboratory or agency, or the **Engineer**, and shipped to the laboratory by the **Contractor** at **Contractor**'s expense.

G. Copies of all correspondence between the **Contractor** and testing agencies shall be provided to the **Engineer and Owner**.

1.04 QUALITY ASSURANCE

A. Testing shall be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

B. (Not Used)

1.05 PRODUCT HANDLING

A. 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 the progress of the Work.

B. (Not Used)

1.06 FURNISHING MATERIALS

A. The **Contractor** shall be responsible for furnishing all materials necessary for testing.

B. (Not Used)

1.07 CODE COMPLIANCE TESTING

A. 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.

B. (Not Used)

1.08 CONTRACTOR'S CONVENIENCE TESTING

A. Inspection or testing performed exclusively for the **Contractor**'s convenience shall be the sole responsibility of the **Contractor**.

B. (Not Used)

1.09 SCHEDULES FOR TESTING

A. Establishing Schedule

1. The **Contractor** shall, by advance discussion with the testing laboratory selected by the Owner, 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. Provide all required time within the construction schedule.

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

C. When the testing laboratory is ready to test according to the determined schedule, but is prevented from testing or taking specimens due to incompleteness of the Work, all extra costs for testing attributable to the delay will be back charged to the **Contractor** and shall not be borne by the Owner.

1.10 TAKING SPECIMENS

A. Unless otherwise provided in the Contract Documents, all specimens and samples for tests will be taken by the testing laboratory or the **Engineer**.

B. (Not Used)

1.11 TRANSPORTING SAMPLES

A. The **Contractor** shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.

B. (Not Used)

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 TESTS AND CERTIFICATIONS

A. As a minimum, the following tests shall be performed and the following certification provided:

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

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

3. Concrete:

    a. Certified test results of all concrete in accordance with ASTM C31, C39 and C172.

    b. Slump tests:

        i. Perform slump tests on the job in accordance with ASTM standards.

        ii. One (1) slump test shall be performed for each 25 cubic yards of concrete.

B. Steel and Miscellaneous Metal: Reinforcing steel, structural steel and miscellaneous metal may be inspected visually on site by the **Engineer**.

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

D. Laboratory tests of compacted backfill shall be made in accordance with ASTM D698. In-place density tests shall be made in accordance with ASTM D1556 or D2922.

E. Bituminous Concrete Pavement: Material testing for bituminous concrete shall be performed as directed by the **Engineer**. Refer to paragraph 3.11 of **Section 02510 – Asphalt Paving**.

+++ END OF SECTION 01410 +++

SECTION 01450
SPECIAL INSPECTION AND TESTING AND OBSERVATION

PART 1 – GENERAL

1.01 SUMMARY

A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with Chapter 17 of the 2018 IBC and is in addition to and supplements requirements included in Statement of Special Inspections provided in Supplement located at end of this section. Special Inspections and Tests hereafter will be referred to as Special Inspections.

B. A Statement of Special Inspections Form and the Final Report of Special Inspections Form of their own format shall be prepared for each of the following locations unless otherwise approved by the Agency Having Jurisdiction (AHJ).

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.

2. International Code Council (ICC):

   a. International Building Code (IBC).

   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.

1.03 DEFINITIONS

A. Agencies and Personnel:

1. Agency Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

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

3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.

4. Special Inspector: Qualified person selected by Owner (or agent of Owner), who will demonstrate competence to the satisfaction of AHJ for inspection of a particular type of construction or operation requiring Special Inspection.

B. Statement of Special Inspections: Detailed written procedure establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.

C. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.

2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.

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

D. Structural Systems and Components:

1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.

2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.

3. Seismic-Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on Drawings.

4. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless otherwise noted on Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.

5. Wind-Force-Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on Drawings.

E. Nonstructural Components:

1. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.

2. Mechanical Component Supports: Structural members or assemblies which transmit loads and forces from mechanical equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

F. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.

2. Requirements are indicated on Statement of Special Inspections.

3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces and installation of deep foundation elements by a registered design professional for general conformance to Contract Documents.

4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.

1.04 SUBMITTALS

A. Contractor's Statement of Responsibility: Form shall be completed by entity responsible for construction of main seismic-force-resisting system, listed in Statement of Special Inspections. Refer to Article Supplements.

B. Fabricator's Certificate of Compliance: Form shall be completed by entity responsible for shop fabrication of structural load-bearing members and assemblies. Refer to Article.

C. Pre-construction meeting minutes.

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated under IBC Section 1705 and subject to Special Inspection under Section 1705: See Drawings for basic lateral load resisting systems for each structure and other designated seismic systems.

2. Wind-force-resisting systems designated under IBC Section 1705: None required.

3. Architectural, Mechanical, and Electrical Components subject to Special Inspection under IBC Section 1705.12.5, 1705.12.6, and 1705.13 for Seismic Resistance: As listed in Statement of Special Inspection for Seismic Resistance.

B. Statement of Special Inspections:

1. As included in Supplement located at end of this section and in support of building permit application, Project-specific requirements were prepared by Registered Design Professional in Responsible Charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work.

   a. Designated seismic systems and main seismic-force- and wind-force-resisting systems and components that are subject to Special Inspection for lateral load resistance.

   b. Special Inspection and testing required by IBC Section 1705 and other applicable sections and referenced standards therein.

   c. Type and frequency of Special Inspection required.

d. Type and frequency of testing required.

e. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to **Engineer, Contractor, building official, and Owner.**

f. Geotechnical Observation to be Performed: Required frequency and distribution of Geotechnical Observation reports by registered design professional to Contractor, building official, and Owner.

C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by Agency Having Jurisdiction's (AHJ) approved, qualified inspection staff. Owner (or agent of Owner) will secure and pay for services of agency to perform Special Inspection and associated testing.

D. Code required Special Inspection with associated testing and Professional Observation, as provided in Statement of Special Inspections and further provided in this section, is for benefit of Owner and does not:

1. Relieve Contractor of responsibility for providing adequate quality control measures.

2. Relieve Contractor of responsibility for damage to or loss of material before acceptance.

3. Constitute or imply acceptance.

4. Affect continuing rights of Owner after acceptance of completed Work.

E. The presence or absence of code required Special Inspector and Professional Observer does not relieve Contractor from Contract requirements.

F. Contractor is responsible for additional costs associated with Special Inspection, Observation and Testing when Work is not ready at time identified by Contractor and Special Inspectors and Professional Observer are onsite, but not able to provide contracted services.

G. Contractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and Professional Observers required because of rejection of materials of in place Work that cannot be made compliant to Contract Document without additional inspections, observation, and testing.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 GENERAL

A. Requirements of the Statement of Special Inspections are provided by the **Owner**. All other testing and inspections, unless noted otherwise, are provided by **Contractor**.

B. Prepare pre-construction meeting agenda and organize meeting. Notify attendees at least 14 days in advance. Provide meeting room.

C. Provide access to shop or Site for Special Inspection and Testing and Professional Observation requirements.

D. Notify **Owner** in advance of required Special Inspection and Professional Observation no later than 48 hours prior to date of Special Inspection and Professional Observation.

E. Provide access for Special Inspector to construction documents.

F. Retain special inspection records on-site to be readily available for review.

G. Cooperate with Special Inspector and provide safe access to the Work to be inspected.

H. Submit Fabricator's Certificates of Compliance for approved fabricators.

I. Provide reasonable auxiliary services as requested by the Special Inspector. Auxiliary services required include, but not limited to:

1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test/inspections.

2. Providing storage space for the Special Inspector’s exclusive use, such as for storing and curing concrete test samples and delivery of samples to testing laboratories.

3. Providing the Special Inspector with access to all approved submittals.

4. Providing security and protection of samples and test equipment at the Project Site.

5. Provide samples of materials to be tested in required quantities.

J. When required by Registered Design Professional in Responsible Charge, provide access for mechanical and electrical component inspections for those items requiring certification.

K. Materials and systems shall be inspected during placement where Continuous Special Inspection is required.

L. Where Periodic Special Inspection is indicated in the Statement of Special Inspections:

1. Schedule inspections for either during or at completion of their placement or a combination or both.

2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.

3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of all Work requiring periodic inspection.

3.02 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. Contractor’s Statement of Responsibility.

2. Fabricator’s Certificate of Compliance.

3. Statement of Special Inspections.

3.03 ADDITIONAL REFERENCES

A. The additional references listed below, following “End of Section,” are provided for reference, but are not part of this specification:

1. Special Inspections Daily Report.

2. Special Inspections Interim Report.

3. Special Inspections Discrepancy Notice.

4. Special Inspections Discrepancy Log.

5. Final Report of Special Inspections.

6. Special Inspections Cast-in-Place Concrete Construction Checklist.
7. Special Inspections Concrete Anchor/Dowel Installation Checklist.
8. Special Inspection Masonry Construction Checklist.

+++ END OF SECTION 01450 +++

SECTION 01540
SECURITY AND SAFETY

PART 1 – GENERAL

1.01 SECURITY PROGRAM

A. The **Contractor** shall protect the Work, including field office trailers and contents, from theft, vandalism, and unauthorized entry.

B. The **Contractor** shall initiate a site security program at the time of mobilization onto the Work site that provides adequate security for material stored and installed onsite.

C. The **Contractor** shall maintain the security program throughout the Contract duration.

D. The **Contractor** and subcontractors shall be wholly responsible for the security of its storage compound and laydown areas, and for plant, material, equipment, and tools at times.

E. The **Contractor** shall provide the **Owner** with a list of 24-hour emergency phone numbers, including chain of command.

F. The **Contractor** must cooperate with Owner on all security matters and must promptly comply with any project security arrangements established by the Owner or Program Manager.

G. It is the **Contractor's** obligations to comply with all applicable governmental requirements and regulations and to undertake reasonable actions to establish and maintain secure conditions at any job site.

H. The **Contractor** shall be solely responsible for the safety and security of materials, equipment, their employees, their subcontractors and or any person who enters **Owner**'s premises for any reason(s) related to this contract.

I. The **Contractor** shall comply with the site safety and security program at all times on the Owner's facilities.

J. The **Contractor** shall not allow cameras on-site or photographs to be taken, except those required to perform the Work in accordance with the Contract Documents or otherwise approved by Owner. Photos taken on the **Owner** property for any reason (mishaps, near misses, accidents etc.) are prohibited from being used for Social Media and Training references unless authorized by the **Owner**.

K. It is the responsibility of the **Contractor** to ensure all articles of possible personal or monetary value found by the Contractor's employees are turned into the Owner or Program Manager.

L. The **Contractor** shall be responsible for maintaining satisfactory standards of employees' competency, conduct, courtesy, appearance, honesty and integrity, and shall be responsible for taking such disciplinary action with respect to any employee, as may be necessary.

M. The **Contractor** shall provide the **Owner** with a list of 24-hour emergency phone numbers, including a chain of command.

N. **Contractors** with non-English speaking employees shall provide an English speaking person, who has the ability to translate or communicate vital project specific or safety information.

1.02 PROJECT SAFETY

A. DRUG AND ALCOHOL POLICY

Any person under the influence of /or in possession of, distributing and/or selling controlled substances and/or alcohol will be removed from the site immediately. Prescription medication is allowable if it is contained in its original package and does not affect an employee's performance. B. COMPETENT PERSON REQUIREMENTS

Contractor and their Subcontractor shall have a Competent Person on the project for all operations as required by OSHA Standards.

1. A competent person identified and on-site before any scaffold erection may begin and/or modified.

2. A competent person identified and on-site before any excavation may begin and/or modified.

3. A competent person identified and on-site before any Confined Space may begin.

4. A competent person identified and on-site before any rigging operation may begin.

5. A competent person identified to erect and inspect concrete formwork.

   OSHA defines a competent person as one who is capable of identifying existing and predictable hazards in surroundings or working conditions

that are unsanitary, hazardous or dangerous to employees, and who has the authority to take prompt corrective measures to eliminate them.

B. COMMUNICATIONS

1. Contractor shall Plan and execute all work in a manner, which complies with the stated objectives of their Project Safety Program.

2. Contractor employees and their subcontractors shall complete a Project Site-Specific Health and Safety Orientation identifying projects hazards, detailing these specified project rules and **Owner** project rules. Employees shall complete this orientation before starting work.

3. Contractor shall create and maintain for project(s) an emergency action plan (EAP) which addresses the notification of the closet police, fire or ambulance and rescue services.

4. Contractors are required to have on file in the job trailer, a copy of their company's Safety Program and Hazard Communication Program.

5. All accidents must be reported to **Owner** immediately after occurrence. Accident reports and investigation forms must be completed and a copy to the **Owner** within 24 hours of an accident. All incidents or near misses must be reported to **Owner** immediately for proper investigation and corrective actions to ensure prevention.

6. Contractor's accident/incident report shall contain (but not be limited too) the following:

    a. Name of person injured

    b. Date and time of injury

    c. Name(s) of all witnesses

    d. Details of the accident

    e. Root Cause analysis of accident

    f. Action taken to prevent re-occurrence of incident/accident

    g. Nature/Extent of injury

    h. Name of doctor/ emergency provider

7. All contractor personnel requiring medical attention shall be drug screened

in accordance with the **Owner**'s policy.

8. Tool Box Talks must be completed at least weekly. The toolbox talk must be documented with the signatures of all employees attending. Topics should include information relative to ongoing or upcoming operations and previous week's accidents.

9. Subcontractors must maintain and have available first aid and bloodborne pathogens kit.

10. **Contractors** and their subcontractors are responsible for transportation and payment for treatment of their employees. It is the responsibility of each contractor to arrange for medical treatment of his or her injured employees.

11. **Contractors** and Subcontractors are responsible for the conduct of their employees and housekeeping of the construction/project site.

12. Any damage to existing or stored property or materials will financially be the sole responsibility of the offending subcontractor(s).

C. DISCIPLINARY POLICY

1. Contractor employees must work safely as a condition of employment on this project. **Owner** reserves the right to remove any contractor employees from this project for unsafe behavior or failure to follow safe work practices. Insubordination or any act that causes an Immediately Dangerous to Life and Health (IDLH) situations will not be tolerated and will result in automatic removal.

D. PROJECT SITE

1. Report all unsafe site conditions to **Owner** for which the **Contractor** does not have the resources or is not responsible to implement corrective action.

2. Only trained, certified and authorized employees shall operate forklifts, aerial lifts, cranes, machinery, heavy equipment, tools, and vehicles. All equipment shall be operated in accordance with the manufacturer's specifications and all other applicable laws/standards. The operator must have certification cards on their person.

3. Cell phones are not allowed to be used onsite except for supervisors and management.

4. All subcontractors shall have warning devices on moving equipment

and trucks in the proper working order while on site.

E. ELECTRICAL

Subcontractors must use either an assured grounding program and/or Ground Fault Circuit Interrupters (GFCI) for protection from shock/electrocution.

F. HAZARDOUS COMMUNICATION PROGRAM

Contractors are required to have on file with **Owner** and project job trailer, a copy of their company's Hazard Communication Program. Hazard Communication programs must include an inventory list of hazardous materials, explanation of their labeling system, and all corresponding safety data sheets (SDS) and name of the program coordinator. **Contractor** shall make the inventory list of hazardous materials available upon request by the **Owner**.

1.03 ENTRY CONTROL

A. The **Contractor** shall restrict entry of unauthorized personnel and vehicles onto the Project site.

B. The **Contractor** shall allow entry only to authorized persons with proper identification.

C. The **Contractor** shall maintain an Employee Log and Visitor Log and make the log available to the **Owner** upon request. This log shall be submitted to the **Owner** bi-weekly, or as necessary.

D. The **Contractor** shall require 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 **Owner** bi-weekly and maintained in the **Contractor's** security files on-site. See **Section** A.

E. The **Contractor** shall require each employee to sign the Employee Acknowledgment of Project Site Rules Log included in **Section C**. 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.

F. The **Owner** 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, or conduct rules.

1.04 BARRICADES, LIGHTS, AND SIGNALS

A. 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 is 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.

B. The **Contractor** shall be held responsible for damage to the Work and any resulting injuries due to failure of barricades, signs, and lights. Whenever evidence is found of such damage, the **Contractor** shall immediately remove the damaged portion and replace it at the **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 **Owner**.

1.05 CONTRACTOR SAFETY/HEALTH AND SECURITY PLAN

A. Within 30 days of Notice to Proceed, and prior to the performance of any Work, the **Contractor** shall prepare and submit a Contract-specific Health, Safety, and Security Plan signed by an officer of the **Contractor's** organization. Adequacy is the responsibility of the **Contractor**.

B. The **Owner** will review the **Contractor's** Health, Safety, and Security Plan for the adequacy of the plan. The plan shall:

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

2. Address safe Work procedures for the activities within the **Contractor's** scope of Work.

3. Include a new employee orientation program to address job- and site-specific rules, regulations, and hazards.

4. Include the **Contractor's** Drug-Free Work Place Policy describing the substance abuse prevention and testing program.

5. Include provisions to protect the **Contractor's** employees, other persons, and organizations possibly affected by the Work from injury, damage, or loss.

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

7. Include a site-specific emergency action and evacuation plan.

8. Include Hazard Communication/Right-To-Know Program.

9. Include security procedures for the **Contractor's** Work, tools, and equipment.

10. Include the capability of providing the **Owner** with documentation to show compliance with the plan, plus accidents, and investigation reports.

11. Address other contract-specific requirements, including the Unique Requirements of these specifications.

C. Prior to the start of Work, **Contractor** shall provide Job Safety Analyses (JSAs) for unique Work activities necessary to prosecute the scope of Work.

D. Review of the **Contractor's** Health, Safety, and Security Plan by the **Owner** shall not impose any duty or responsibility upon the **Owner** for the **Contractor's** performance of the Work in a safe manner.

E. 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.

F. The **Contractor** shall provide the **Owner** with safety reports, training records, competent person list, and accident reports prepared in compliance with Fed/OSHA and the Project Health, Safety, and Security Plan.

1.06 PROJECT SAFETY COORDINATOR

A. The **Contractor** shall be responsible for the safety of the **Contractor's** and **Owner**'s employees, the **Owner's** personnel and other personnel at the Work site. The **Contractor** shall identify a Project Safety Coordinator (PSA) on the job with an appropriate office on the job site to maintain and keep available safety records and up-to-date copies of pertinent safety rules and regulations.

B. The Project Safety Coordinator shall:

1. Comply with applicable health and safety requirements of governing legislation.

2. Schedule and conduct safety meetings and safety training programs as required by law and included in the **Contractor** Health, Safety, and Security Plan for personnel engaged in the Work.

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

4. Post the name(s), address and hours of the nearest medical doctor(s), names and addresses of nearby clinics and hospitals, and the telephone numbers of the fire and police departments.

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

6. 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 preservers, oxygen breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, explosion meters; and other equipment mandated by law.

7. Inspect each Work crew at least once daily in accordance with an Inspection Checklist Report Form to make sure that workers are wearing their appropriate personal safety equipment; machines, tools, and equipment are in safe operating condition; Work methods are not dangerous; and the Work site and Work methods are free of hazards.

8. Submit to the **Owner,** upon request, copies of inspection checklist report forms; safety records, safety inspection reports, and certifications from regulating agencies and insurance companies.

9. Immediately notify the **Owner** of a serious accident, followed by a detailed written report within 24 hours. “Serious accident” is defined as that requiring an absence of Work of more than two days and/or hospitalization.

10. Immediately notify the **Owner** in the event of a fatal accident.

11. Immediately notify the **Owner** of any accident claim against the **Contractor** or any subcontractor, followed by a detailed written report on the claim, and its resolution.

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

1.07 JOBSITE SECURITY

A. The **Contractor** shall be responsible for maintaining a safe “drug-free” work environment.

B. The **Contractor** shall develop a Security Plan for use on the job site during construction. The Plan shall encompass at a minimum such topics as the use of pre-employment background checks for specific project staff, drug tests, crime prevention and anti-theft procedures, workplace violence, and methods

to secure project documents. The staff working on the site shall be familiar with the requirements of the Security Plan.

C. Persons on the jobsite shall report any suspicious activity by workers or by others at the jobsite area first to the Project Management, and/or Spalding County Police and/or Fire Department by calling 911 and immediately to the **Owner**.

1.08 REMOVAL

A. The **Contractor** shall remove equipment and devices when no longer required and repair damage caused by installation.

B. Should the **Contractor** dismiss employees who have been given access to the **Owner** facilities while the contract is in force, the **Contractor** will advise the **Owner**.

C. The Owner may request the **Contractor** to immediately remove from the premises and/or dismiss any employee found unfit to perform duties due to one or more of the following reasons:

1. Neglect of duty, absenteeism, security or safety problems and sleeping on the job.

2. Disorderly conduct, use of abusive or offensive language, quarreling, intimidation by words, actions or fighting.

3. Theft, vandalism, immoral conduct or any other criminal action.

4. Selling, consuming, possessing, or being under the influence of intoxicants, alcohol or illegal substances, which produce similar effects while on duty.

5. Involved in a vehicle accident while on the Owner's property or driving the Owner's equipment. No employee, Contractor, or Subcontractor will be extended privileges to drive the Owner's equipment on the Owner's property if driving privileges have been withdrawn by the person's State of residence.

D. All employees will be required to sign in and out on a designated log sheet.

E. No one under age sixteen is permitted at work sites after normal working hours. Contractor's employees are allowed on work sites only during the specified hours and only when working on this contract. No Contractor employee will be allowed on sites when not specifically working on this Contract's predetermined times and dates.

F. All employees and agents of the Contractor must read the Project Site Rules statement and sign a log acknowledging understanding of project site rules provided in **(Sections A & C)**.

SECTION A

VISTOR 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 **Owner** directly or indirectly for the **Owner**, I waive on behalf of myself, my heirs, employer, legal representatives and assigns and hereby release and discharge the **Owner**, each of its directors, officers, employees, representatives, and agents from any and all claims, actions, causes of action, or any charge of any kind whatsoever that 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 **Owner** property
- Violation of safety or security rules or procedures
- Possession of firearms or lethal weapons on jobsite
- Acts of sabotage
- Destruction or defacing of **Owner** property
- Failure to use sanitary facilities
- Knowingly or purposely failing to report accidents/incidents 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 job site

- Wearing shorts or tennis shoes on the job site
- Failure to wear required personal protective equipment (PPE)
- Gambling, fighting, threatening behavior or engaging in horseplay on the job site
- Smoking in unauthorized areas on the job site
- Open fire cooking or making unauthorized fires on job site
- Selling items or raffles without authorization
- Use of unauthorized cameras on the job site
- 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
- Condoning or knowingly allowing a person to engage in or work around a patently unsafe or environmental compromising act or condition
- Knowingly or purposely falsifying records, documents or providing false testimony

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.

Print Name	**Signature**
Date	

SECTION B

VISITOR LOG

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

NAME PRINT	SIGNATURE	COMPANY/PERSON VISITED	DATE	IN	OUT
				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm
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				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm
				am/pm	am/pm

SECTION C

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 **Owner** property
- Violation of safety or security rules or procedures
- Possession of firearms or lethal weapons on jobsite
- Acts of sabotage
- Destruction or defacing **Owner** 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/safety glasses and safety vest
- 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.

Print Name	**Signature**
Date	

SECTION D

EMPLOYEE LOG

BY SIGNING THIS LOG ACKNOWLEDGMENT, I HAVE READ AND UNDERSTAND, AND AGREE TO ABIDE BY THE PROJECT RULES OUTLINED ABOVE AND ANY STATE, FEDERAL, LOCAL, OR ANY OTHER CONTRACT OBLIGATIONS THAT MAY APPLY. I FURTHER ACKNOWLEDGE THAT I HAVE BEEN ORIENTED 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:*	

Primary Contractor: _____

Owner Contract #:_____

Subcontractor Name: _____

Contract End Date: _____

+++ END OF SECTION 01540 +++

SECTION 01600
GENERAL MATERIAL
AND EQUIPMENT REQUIREMENTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. The **Contractor** shall use the latest version of the manufacturer's product line of installed materials and equipment at the time of purchase. The **Contractor** shall not purchase materials and equipment that have been outdated by newer versions at the time of purchasing. Materials and equipment that show any signs of extended storage such as corrosion, scratches, and dents shall not be accepted.

B. The **Contractor** shall use equipment for performing the Work that conforms to the latest version of 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 shall be barred from use on the project.

C. The **Contractor** shall install material and equipment that meets or exceeds 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, the **Contractor** shall comply with the more stringent requirements with no additional compensation to the **Contractor**.

PART 2 - MATERIALS AND EQUIPMENT

2.01 ANCHOR BOLTS

A. The **Contractor** shall use anchor bolts that are ANSI Type 316 stainless steel unless otherwise specified or indicated and shall conform to requirements of this Section and the material articles in the appropriate Sections where they are used.

B. The **Contractor** shall use anchor bolts supplied by the manufacturer or fabricator of the specific material or equipment to be installed.

C. Design criteria for anchor bolts:

1. 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.

2. Post-installed anchor bolts shall be designed based on “cracked” concrete conditions for design purposes, unless otherwise demonstrated by calculations.

3. 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 half the total weight of pipe, fittings, valves, accessories, and water contained in full 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

4. Embedment depth shall be minimum 6 inches for epoxy anchors and 4 inches for steel expansion anchors, unless noted otherwise on the drawings.

D. Anchor Type and Manufacturer

1. Where epoxy anchors are noted on the Drawings, provide ANSI Type 316 stainless steel threaded rod with one of the following adhesives:

    a. Pure 110+; DeWalt.

b. HIT RE 500-V3 or HIT HY 200; HILTI North America.

c. SET-3G; Simpson Strong-Tie.

d. Or approved equal.

2. For other applications, provide ANSI Type 316 steel expansion anchors from one of the following manufacturers:

a. DeWalt

b. HILTI North America

c. Simpson Strong-Tie

d. Or approved equal.

3. Install anchors per manufacturer's recommendations and this Section.

a. Drilled anchorage holes are to be blown out with compressed air before installing anchor.

2.02 CONNECTION BOLTS

A. 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.

B. 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. Threads shall be clean cut and shall conform to ANSI Standard B1.1-1989 for Unified Inch Screw Threads (UN and UNR Thread Form).

2.03 CONCRETE INSERTS

A. 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 that permits adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. Inserts shall be galvanized, then epoxy phenolic primed and top coated with PVC, using thermal bond process.

2.04 SLEEVES

A. 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 inches above the finished floor surface. Threaded nipples shall not be used as sleeves.

B. Sleeves in exterior walls below grade or in walls to have liquids on one or both sides shall be as detailed on the Approved Drawings and specified in other sections.

C. Sleeves shall be set accurately before the concrete is placed or shall be built in accurately as the masonry is being built.

2.05 ELECTRICAL EQUIPMENT ENCLOSURES

A. 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.

2.06 EQUIPMENT DRIVE GUARDS

A. 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 that will permit easy removal for servicing the equipment. The guards shall conform to applicable safety codes and regulations.

2.07 NAMEPLATES

A. The **Contractor** shall provide each piece of equipment, with the exception of the items mentioned below, 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.

B. This requirement shall also apply to standard, manually operated gate, lobe, check, and plug valves.

C. 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.

2.08 LUBRICANTS

A. During testing and prior to acceptance, the **Contractor** shall furnish lubricants necessary for the proper lubrication of equipment furnished under this Contract.

2.09 PROTECTION AGAINST ELECTROLYSIS

A. Where dissimilar metals are used in conjunction with each other, the **Contractor** shall provide suitable insulation between adjoining surfaces to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, or washers, or other approved acceptable materials.

2.10 TRANSPORTATION, HANDLING, STORAGE, AND PROTECTION

A. Packing and Shipping:

1. Product and materials shall be shipped and handled in ways that shall prevent damage.

2. 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.

3. Ship equipment, material, and spare parts in assembled units except where partial disassembly is required by transportation regulations or for protection of components.

4. 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.

5. Stiffeners shall be used where necessary to maintain shapes and to give

rigidity.

6. 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.

B. Acceptance at Site:

1. Damaged items shall not be permitted as part of the Work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the **Owner**.

2. Damage shall be corrected to conform to the requirements of the Contract before the assembly is incorporated into the Work.

3. The **Contractor** shall bear the costs arising out of dismantling, inspection, repair, and reassembly.

C. Storage and Protection:

1. 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 protect against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

2. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation and ultraviolet (UV) degradation. 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

A. 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, and the supplier shall provide components of the system to enhance compatibility, ease of construction, and efficient maintenance. The **Contractor** shall be responsible to the **Owner** for performance of systems in accordance with the provisions of t of the Contract Documents.

B. Where the detailed specifications require the **Contractor** to furnish a certificate of unit responsibility, such certificate shall be 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.

+++ END OF SECTION 01600 +++

SECTION 01610
TRANSPORTATION AND HANDLING

PART 1 – GENERAL

1.01 SCOPE

A. The **Contractor** shall provide transportation of 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, as well as other Work and incidental items necessary or convenient to the **Contractor** for the satisfactory prosecution and completion of the Work.

B. Equipment, materials, and products damaged during transportation or handling shall be repaired or replaced by the **Contractor** at no additional cost to the **Owner** prior to being incorporated into the Work. Acceptance of damaged goods is at the discretion of the **Owner**.

1.02 TRANSPORTATION

A. Equipment shall be suitably boxed, crated, or otherwise protected during transportation.

B. Where equipment will be installed using existing cranes or hoisting equipment, the **Contractor** shall confirm that the weights of the assembled sections do not exceed the actual capacity of the cranes or hoisting equipment.

C. Small items and appurtenances such as gauges, valves, switches, instruments, and probes that could be damaged during shipment shall be removed from the equipment prior to shipment, packaged, and shipped separately. Openings shall be plugged or sealed to prevent the entrance of water or dirt.

1.03 HANDLING

A. Equipment, materials, and products shall be carefully handled to prevent damage or excessive deflections during unloading or transportation.

B. 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.

C. 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.

D. Slings and chains shall be of size and capacity rating to safely support the weights of items to be unloaded. Slings and chains shall be regularly inspected and tagged as in good conditions in accord with OSHA requirements. Slings and chains shall be padded as required to prevent damage to protective coatings and finishes.

+++ END OF SECTION 01610 +++

SECTION 01640
MANUFACTURERS' SERVICES

PART 1 - GENERAL

1.01 DEFINITIONS

A. Reference **Section 01650 - Installation, Testing and Startup Services**.

B. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02 SUBMITTALS

A. 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. Preliminary Training Plan: Submit within 120 days after Notice to Proceed.

2. Training Schedule: Submit not less than 30 days prior to start of equipment installation and revise as necessary for acceptance.

3. Final Training Plan: Submit after training coordination meeting.

4. Training Materials:

a. Submit written outlines of proposed training sessions not less than 30 days prior to scheduled training.

b. 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.

c. Quality Control Submittals: When specified in the individual Specifications, submit:

d. Qualifications and resume of Manufacturer's Representative performing specified services.

e. Manufacturer's Certificate of Proper Installation: On form appended to this section.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. 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.

B. Representative subject to acceptance by **Engineer**. No substitute representatives will be allowed unless prior written approval by **Engineer** has been given.

1.04 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. 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.

B. Schedule manufacturer's services to avoid conflicting with other onsite testing or other manufacturer's onsite services.

1. Determine that all conditions necessary to allow successful testing have been met before scheduling services.

2. Only those days of service approved by Engineer will be credited to fulfill the specified minimum services.

3. If specified, manufacturer's onsite services shall be 8 hours minimum and include as a minimum:

4. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.

5. 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.

6. Revisiting the site as required to correct problems and until installation and operation are acceptable to Engineer.

7. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.

8. Assistance during functional and performance testing and startup demonstration, and until product acceptance by the Owner.

9. Training of **Owner’**s personnel in the operation and maintenance of respective product as required.

10. 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.

11. Additional requirements which may be specified elsewhere.

1.05 TRAINING PLAN

A. 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.

B. 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.

1.06 TRAINING SCHEDULE

A. 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.

B. 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.

C. Coordinate with Progress Schedules as specified in the Special Conditions, if any, and **Section 01650 - Installation, Testing and Startup Services**.

1.07 TRAINING OWNER'S PERSONNEL

A. 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.

B. 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.

C. Manufacturer's Representative: Familiar with plant operation and maintenance requirements as well as with specified equipment.

D. 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.

E. 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.

F. 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 video taped. All trainers are to provide their full cooperation to the Owner's video technician.

1.08 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” 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)

SPALDING COUNTY WATER AUTHORITY
PDB Sewer Implementation Project

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)

SPALDING COUNTY WATER AUTHORITY
PDB Sewer Implementation Project

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 SCWA 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 Owner's Representative

_____ _____
Date Signature of Contractor's Representative

+++ END OF SECTION 01640 +++

SECTION 01650
INSTALLATION, TESTING, AND STARTUP SERVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The **Contractor** shall supply the on-site services of supplies and/or manufacturers' representatives during construction and startup of equipment.

B. The **Contractor** shall include and pay all costs for suppliers/manufacturers' services rendered.

C. Training shall be provided by competent manufacturer's representatives in accordance with **Section 01640 - Manufacturer's Services**.

1.02 INSTALLATION SERVICES

A. Competent and experienced technical representatives of manufacturers of all equipment and systems shall be provided as necessary to resolve assembly to installation procedures which are attributable to or associated with the equipment furnished.

B. After installation of the equipment/system has been completed and the equipment/system is presumably ready for operation, but before it is operated by others, the manufacturer's representative shall inspect, operate, test, and adjust the equipment/system so equipment/system conforms to specifications and manufacturer's requirements. The inspection shall include, but 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.

C. 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.

D. Not later than four days prior to training session, the **Contractor** shall provide the **Owner** with three copies of the following for approval:

1. Manufacturer's representatives shall certify the following for each piece of equipment or each system installed in the work:

   a. That the equipment is installed per the contract specifications.

   b. That nothing in the installation shall void the warranty.

   c. That the equipment, as installed, is ready to be operated by others.

   Use "Certificate of Installation Services" form provided with this section and furnish **Owner** with three copies for approval.

2. Submit a detailed report by the manufacturer's representative, for approval by the **Owner**, of the startup services performed. The report shall include, but not be limited to:

   a. Results of inspection and operation; quantitative and/or qualitative, as specified.

   b. Description of calibration and adjustments.

   c. Description of any parts replaced and why replaced.

   d. Type, brand name and quantity of lubricant used, if any.

   e. General condition of equipment.

   f. Description of any problems encountered and corrective actions.

   g. Any special instructions left with the **Contractor** or **Owner**.

   h. Suggestions for precautions to be taken to ensure proper maintenance.

   The report must be approved before startup.

E. After the **Owner** has approved the reports from the manufacturer's representatives, the **Contractor** shall make arrangements to have the manufacturer's representatives present when the field acceptance tests are made.

PART 2 - PRODUCTS

2.01 MATERIALS TESTING

A. Gages, Meters, Recorders and Monitors: Gages, meters, recorders and monitors shall be provided by the **Contractor** as required by the **Engineer** to supplement or augment the instrumentation system provided under this contract to properly demonstrate that all equipment fully satisfies the requirements of this project manual. All instruments shall be recently calibrated, and the **Contractor** shall be always prepared to demonstrate, through recalibration, the uncertainty of all instruments employed for testing purposes. Calibration procedures shall be in accordance with applicable standards of ASTM, ISA and IEEE. The adequacy of all gages, meters, recorders and monitors shall be subject to review of the **Owner**.

B. Records: The **Contractor** shall provide sign-off forms for all installed and operational testing to be accomplished under this contract.

1. The **Contractor** shall maintain a master file of all equipment sign-off sheets, which shall be available for inspection by the **Owner and Engineer**. Upon completion of testing, the **Contractor** shall furnish the **Owner** with the original and two copies of the sign-off sheet for each equipment item.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS:

A. All materials, equipment, and work provided in this contract shall be tested and inspected to prove compliance with the contract requirements. The work shall include the equipment supplied by others but installed and/or connected by the **Contractor**. Unless otherwise specified, all costs of testing, including temporary facilities and connections shall be borne by the **Contractor**. For the

B. purpose of this section, "equipment" shall mean any mechanical, electrical, instrumentation, or other device with one or more moving parts or devices requiring an electrical, pneumatic or hydraulic connection. Testing shall be performed in accordance with the requirements of the particular specification sections for the item to be tested.

C. No tests specified herein shall be applied until the item to be tested has been inspected and approval given by the **Owner** for the application of such test.

D. Tests and inspections, unless otherwise specified or accepted, shall be in accordance with the recognized standards of the industry.

E. The form of evidence of satisfactory fulfillment of delivery acceptance test and of installed test and inspection requirements shall be at the discretion of the **Owner**, either by tests and inspections carried out in his presence or by certificates or reports of tests and inspections carried out by approved persons or organizations. The **Contractor** shall provide and use forms that include all test information, including specified operational parameters, and shall be acceptable in content to the **Owner**.

3.02 DELIVERY ACCEPTANCE TESTS AND INSPECTIONS

A. The delivery acceptance tests and inspections shall be at the **Contractor**'s expense for any materials or equipment specified herein and shall include the following:

1. Test of items at the place of manufacture during and/or on completion of manufacture, comprising material tests, hydraulic pressure tests, electric and instrumentation subsystem tests, performance and operating tests and inspections in accordance with the relevant standards of the industry.

2. Inspection of all items delivered at the site or to any authorized place of storage in order that the **Owner** may be satisfied that such items are of the specified quality and workmanship and are in good order and condition at the time of delivery. To that end, the **Contractor** shall be prepared to remove all coverings, containers, or crates to permit the **Owner** to conduct his inspection. Should the **Owner** find, in his opinion, indication of damage or deficient quality of workmanship, the **Contractor** shall provide the necessary documentation or conduct such tests deemed necessary by the **Owner** to demonstrate compliance.

3.03 INSTALLED TESTS AND INSPECTIONS

A. General: All equipment shall be tested by the **Contractor** to the satisfaction of the **Owner** before any facility is put into operation. Tests shall be as specified herein and shall be made to determine whether the equipment has been properly assembled, aligned, adjusted, and connected. Any changes, adjustments, or replacements required to make the equipment operate as specified shall be carried out by the **Contractor** as part of the work.

B. Initial Operation: Once all affected equipment has been subjected to a pre-operational checkout, and the **Owner** has witnessed and has not found deficiencies in that portion of the work, individual systems may be started and

operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications.

1. Potable water or plant utility water, depending on availability, shall be employed for testing. The **Contractor** shall bear all expenses to pump or pipe it to the tested systems. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including 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 power, flushing or cooling water or control air 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 **Owner**. Disposal methods for test media shall be subject to review by the **Owner**.

2. If while under test any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed or replaced, tests shall, if so required by the **Owner**, be repeated within reasonable time and in accordance with the specified conditions. The **Contractor** shall pay to the **Owner** all reasonable expenses incurred by the **Owner** as a result of repeating such tests.

3. Once initial operation has been completed, all machines shall be rechecked for proper alignment, realigned if necessary, and doweled in place. All equipment shall be checked for loose connections, unusual movement or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the **Owner**. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. They shall then be repaired or removed from the site and replaced at no cost to the **Owner**.

4. Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. **Contractor** shall permanently list all testing tolerances on the piece of equipment being tested. Where, in the case of an otherwise satisfactory installed test, any doubt, dispute, or difference should arise between the **Owner** and the **Contractor** regarding the test results or the methods or equipment used in the performance of such test, the **Owner** may order the test to be repeated. If the repeat test, using such modified methods or equipment as the **Owner** may require, substantially confirms the previous test, then all costs in connection with

the repeat test will be paid by the **Owner**; otherwise the costs shall be borne by the **Contractor**. Where the results of any installed test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the **Contractor** at his expense.

5. The **Contractor** shall provide at no expense to the **Owner**, all utilities, supplies, labor and all other necessary items and work required to complete all tests and inspection specified in this section. The **Contractor** shall provide at no expense to the **Owner** temporary heating, ventilating and air conditioning for any areas requiring it in the case where permanent facilities are not complete and operable at the time of installed tests. Temporary facilities shall be maintained until permanent systems are in service.

C. Operational Testing: After completion of all installed testing and certification by the **Owner** that all equipment complies with the requirements of the specifications, the **Contractor** shall fill all process systems and units with the specified fluid.

1. Upon completion of the filling operations, the **Contractor** shall operate the completed systems and processes for a period of not less than 72 hours, during which all systems shall be operated as a complete facility at various operating conditions, as directed by the **Owner, Engineer, or Plant Supplier, as applicable**. Should the operational testing period be halted for any reason related to the facilities constructed or the equipment furnished under this contract, or the **Contractor**'s temporary testing systems, the operational testing program shall be repeated until the specified continuous period has been accomplished without interruption. All process units and systems shall be brought to full operating conditions, including temperature, pressure, and flow.

2. All costs for water, fuel, power, and chemicals required during this test shall be borne by the **Contractor**.

3. Process systems and units shall mean all materials and equipment provided in this contract.

3.04 SYSTEM OPERATIONAL TESTING

A. The duration of the operational tests for the facilities shall be at least 72 hours. Each day the complete facility shall be operated for at least 8 continuous hours. During the 72-hour period, the **Contractor** shall demonstrate the operation of all equipment and all systems installed under

this contract. System commissioning shall commence, with the approval of the **Owner**, upon completion of the operational testing of each portion of the facility, system, or subsystem.

3.05 COMMISSIONING

A. After completion of all installed and operational testing, the **Contractor** shall make written application to the **Owner** for permission to demonstrate compliance of the equipment, structures, and systems furnished and installed under this contract with all requirements of this project manual. Such application shall be furnished to the **Owner** not less than 7 days prior to the commissioning date.

B. Upon receipt of written permission from the **Owner**, and on the agreed upon date, the **Contractor** shall do all things necessary to effect the release of fluid into the facility and to permit adequate operation of the facilities.

C. The **Contractor** shall allow for a commissioning period of at least **30 days** satisfying the **Owner** that the contract requirements have been fulfilled. The commissioning period may be broken into several segments comprising complete systems at the discretion of the **Owner**.

D. During the commissioning period, the **Owner** will provide staff for operation and maintenance of the facility. The **Contractor** shall provide fulltime (8 hours per day for 5 days per week) and on-call (remaining time of 24 hours, 7 days per week) coordinator service to coordinate other **Contractor** personnel including equipment manufacturer service representatives for troubleshooting, training of **Owner** personnel, or repair and maintenance of equipment within the terms of the contract. **Contractor** provided personnel for troubleshooting, repair or maintenance of equipment shall be provided as soon as possible and in no case longer than 8 hours after notification to the **Contractor**'s coordinator. Such coordinators shall be familiar with the facility equipment and operations and shall be acceptable to the **Owner**. "Coordinator service" shall mean attendance at the site for whatever period is required at whatever time necessary in response to a request from the **Owner**. In addition, the **Contractor** shall provide the services of one laborer (8 hours per day for 5 days per week) during the commissioning period to assist **Owner** personnel in general cleanup and maintenance.

E. All costs during commissioning shall be the **Contractor's** responsibility.

+++ END OF SECTION 01650 +++

CERTIFICATE OF INSTALLATION SERVICES

Project: _____

Equipment: _____

Specification Section: _____
Contract: _____

The equipment/system named above has been inspected by the Supplier's/Manufacturer's representative and he hereby certifies:

1. That the equipment/system is installed per the contract specifications.
2. That nothing in the installation shall void the warranty.
3. That the equipment/system as installed is ready to be operated by others.

MANUFACTURER'S REPRESENTATIVE

Signature: _____ Date _____

Name (print):_____

Title: _____

Representing: _____

CONTRACTOR

Signature: _____ Date _____

Name (print): _____

Title: _____

Attach the detailed report called for by specification Section 01650 subparagraph 1.02 and submit three copies to **Owner**.

This form shall be completed and submitted to **Owner** 24 hours prior to training of **Owner**'s personnel.

SECTION 01664
TRAINING

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section contains requirements for training the **Owner**'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.

1.02 QUALITY ASSURANCE

A. Where required by the detailed specifications, the **CONTRACTOR** shall provide on-the-job training of the **Owner**'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.

1.03 SUBMITTALS

A. The following information shall be submitted to the Engineer:

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

2.01 GENERAL

A. Where specified, the **CONTRACTOR** shall conduct training sessions for the **Owner**'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.

2.02 LOCATION

A. Training sessions shall take place at the site of the work.

2.03 LESSON PLANS

A. 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.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the **Owner** 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.

2.04 FORMAT AND CONTENT

A. 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 **Owner**'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:

        1. Reference material.
        2. Daily, weekly, monthly, quarterly, semi-annual, and annual jobs.

    b. Show how to perform PM jobs.

    c. Show **Owner**'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:

1. Who to call.
2. How to get emergency help.

8. Operation and Maintenance Manuals:

   a. Review any other material submitted.

   b. Update material, as required.

2.05 VIDEO RECORDING

A. The **CONTRACTOR** shall advise all manufacturers providing training sessions that the material will be video taped and shall make available to the **Owner**'s video taping **CONTRACTOR** such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3 – EXECUTION

3.01 GENERAL

A. 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/Plant Supplier is to plan for up to two classes in any 24 hour period.

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the **Owner** prior to the start of any training. Video taping shall take place concurrently with all training sessions.

C. 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 **Owner** 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 **Owner** approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

+++ END OF SECTION 01664 +++

SECTION 01700
CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures
2. Final completion procedures
3. Warranties
4. Final cleaning
5. Repair of the Work
6. Specific closeout and special cleaning requirements for the Work in those Sections

1.03 SUBMITTALS

Submit the following shop drawings in accordance with **Section 01300 - Submittals**:

A. Product Data: For cleaning agents.

B. **Contractor's** List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

D. Certificates of Release: From authorities having jurisdiction.

E. Certificate of Insurance: For continuing coverage.

F. Field Report: For pest control inspection.

G. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.04 SUBSTANTIAL COMPLETION PROCEDURES

A. **Contractor's** List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (**Contractor's** punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following: a minimum of (10) days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting **Owner** unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.

3. Submit closeout submittals specified in individual Divisions 02 through 16 Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

4. Submit maintenance material submittals specified in individual Divisions 02 through 16 Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by the **Owner.** Label with manufacturer's name and model number where applicable.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain the signature of an authorized **Owner** representative for receipt of submittals.

5. Submit sustainable design submittals required in Division 01 and in individual Division 02 through 16 Sections.

6. Submit changeover information related to **Owner's** occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following: a minimum of (10) days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise the **Owner** of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver the keys to **Owner**. Advise the **Owner's** personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Instruct **Owner's** personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Division 01 **Section 01664- Training**.

6. Advise **Owner** of changeover in heat and other utilities.

7. Participate with **Owner** in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Remove labels that are not permanent labels.

10. Complete final cleaning requirements, including touchup painting.

11. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of ten (10) days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, **Owner** will either proceed with inspection or notify **Contractor** of unfulfilled requirements. **Owner** will prepare the Certificate of Substantial Completion after inspection or will notify **Contractor** of items, either on **Contractor's** list or additional items identified by **Owner**, that shall be completed or corrected before certificate shall be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection shall form the basis of requirements for final completion.

1.05 STARTING OF SYSTEMS

A. Conform to the requirements of sections within Division 1.

B. Coordinate schedule for start-up of various equipment and systems.

C. Notify **Owner** (seven) days prior to start-up of each item.

D. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

E. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.

F. Verify wiring and support components for equipment are complete and tested.

G. Execute start-up under supervision of applicable manufacturer's representative, **Contractors'** personnel, and **Owner** in accordance with manufacturers' instructions.

H. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, approve equipment or system installation prior to start-up, to supervise placing equipment or system in operation, and to train the **Owner's** staff.

1.06 DEMONSTRATION AND INSTRUCTIONS

A. Conform to the requirements of **Sections 01640 - Manufacturer's Services** and **01650 - Installation, Testing, and Startup Services**.

B. For equipment or systems requiring seasonal operation, perform demonstration for other season within (six) months.

C. Utilize operation and maintenance manuals as the basis for instruction. Review contents of manual with **Owner's** personnel in detail to comprehensively explain the operation and maintenance.

D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at a scheduled and agreed time, for each piece of equipment at each designated location. Time shall be acceptable to the **Owner**.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

F. Required instruction time for each item of equipment and system is specified in individual sections.

1.07 PROJECT RECORDS DOCUMENTS

A. The **Contractor** shall record any actual revisions to the Work and maintain one set of the following Project Record Documents on Site:

1. Contract Drawings, Specifications, and Addenda.

2. Change Orders, Field Orders, and other written notices.

3. Shop drawings, Product data, and samples.

4. Records of surveying and layout Work.

5. Project Record Drawings.

B. The **Contractor** shall record information on the Project Record Documents concurrent with construction progress and store these documents separately from the documents used for construction.

1. The **Owner** will supply a set of Contract Drawings. The **Contractor** shall mark thereon each revision as the Work progresses in order to produce a set of as-built drawings.

2. The **Contractor** shall note any changes made during construction by any of the **Contractor's** forces or those of any subcontractors.

3. The **Contractor** shall dimension the locations of buried or concealed Work, especially piping and conduit, with reference to exposed structures.

4. The **Contractor** shall note the installed locations of concealed service lines on the Site or within the structure by reference from the center line of the service to the structure column lines, to other main finished faces, or to other structural points that are easily identified and located in the finished Work.

5. Certificates of Substantial Performance and Total Performance shall not be issued until as-built drawings are complete and submitted, and the **Contractor** has fully satisfied the requirements for Substantial Performance and Total Performance of the Work.

C. For Project Record Documents and Record Shop Drawings, the **Contractor** shall legibly mark each item to record actual construction, including:

1. Field changes of dimensions and details.

2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

3. Measured locations of internal utilities and appurtenances that are concealed in construction, referenced to visible and accessible features of the Work.

4. Any Changes in the Work from the contract documents.

5. The location of concealed mechanical services and electrical main feeders, junction boxes, and pullboxes.

D. Upon completion of the Work, the **Contractor** shall prepare two USB thumb drive sets of the Record Shop Drawings and an index.

E. The **Contractor**-prepared Record Shop Drawings index shall identify the **Owner's** project number, project name, and Contract number and the contents in the format listed below.

1. The index shall include the following columns of information for each Record Shop Drawing:

   a. Specification Section number

   b. Specification title

   c. Shop drawing transmittal number

   d. Shop drawing equipment description including preselected Equipment vendor and supplier.

2. The index shall be printed by the following two sorts:

   a. Primary sort: Specification Section number. Secondary sort: shop drawing transmittal number.

3. The index shall be generated using Microsoft Excel software. A copy of the electronic file shall be furnished to the **Owner**.

4. The **Contractor** shall provide a set of Project Record Documents on USB thumb drives in an electronic format compatible with the plant record standards. All drawings are to be provided electronically in both AutoCAD (latest version) and Adobe Acrobat PDF (latest version). Also provide a set containing the software implemented on this project, including standard software and custom application software.

1.08 EQUIPMENT INVENTORY SPREADSHEET

A. As part of the **Owner's** asset management program, the **Contractor** shall complete each field for the equipment inventory file for each piece of equipment

and device provided under this Contract, as a requirement for Substantial Performance. An electronic format of the equipment inventory spreadsheet shall be provided by the **Contractor**.

1.09 EQUIPMENT PREVENTIVE MAINTENANCE SPREADSHEET

A. As part of the **Owner's** asset management program, the **Contractor** shall complete each field for each piece of equipment and device provided under this Contract, as a requirement for Substantial Completion. The **Contractor** shall transfer the manufacturer's recommended preventive maintenance tasks and frequencies into the spreadsheet. An electronic format of the equipment inventory spreadsheet shall be provided by the **Contractor.**

1.10 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting them with durable sheet materials.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

1.11 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.

B. Deliver to location as directed by **Owner**; obtain receipt prior to final payment.

C. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers:

D. Stencil on containers:

1. Manufacturer/supplier name

2. Unit name

3. Spare part name

4. Manufacturer catalog number

5. Other identifying information

6. Precautionary information

1.12 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 1.

2. Certified List of Incomplete Items: Submit certified copy of **Owner's** Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by **Owner's** representative**.** Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of the request, the **Owner** will either proceed with inspection or notify the **Contractor** of unfulfilled requirements. The **Owner** will prepare a final Certificate for Payment after inspection or will notify the **Contractor** of construction that shall be completed or corrected before the certificate will be issued.

C. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete has been completed or corrected.

1.13 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction, including, if necessary, areas disturbed by the **Contractor** that are outside the limits of construction.

1. Organize the list of spaces in sequential order, starting with exterior areas first, and proceeding from the lowest floor to highest floor.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

3. Include the following information at the top of each page:

   a. Project name

   b. Date

   c. Name of **Contractor**

   d. Page number

1.14 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of the **Owner** for designated portions of the Work where commencement of warranties other than the date of Substantial Completion is indicated, or when a delay in submittal of warranties might limit the **Owner's** rights under warranty.

B. Partial Occupancy: Submit properly executed warranties within fifteen (15) days of completion of designated portions of the Work that are completed and occupied or used by **Owner** during the construction period, by separate agreement with **Contractor**.

C. Organize warranty documents into an orderly sequence based on the table of contents of Contract Documents.

   1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper or as directed by the **Owner.**

   2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of installer.

   3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of **Contractor**.

   4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the Georgia Code of Regulations maximum allowable volatile organic compound (VOC) levels.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 FINAL CLEANING

A. General: Perform final cleaning as directed by the **Owner.**

B. Construction Waste Disposal: Comply with waste disposal requirements in Division 1 and meet local laws.

3.02 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determining Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of

repair or restoration. Do not paint over "UL" or other required labels and identification, including mechanical and electrical nameplates. Remove any paint that has been applied to required labels and identification.

3. Replace parts that have been subjected to operating conditions during construction that could impede operation or reduce longevity.

4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

3.03 ADJUSTING

Adjust operating products and equipment to ensure smooth and unhindered operation.

+++ END OF SECTION 01700 +++

SECTION 01714
PRE-CONSTRUCTION & POST-CONSTRUCTION INSPECTIONS AND SURVEYS

PART 1 – GENERAL

1.01 DESCRIPTION

A. The Work in this Section includes requirements of the **Contractor** to perform pre- and post-construction inspections for buildings, structures, roads, houses, and other facilities as described herein. The requirements also include performing surveys for determining baseline noise, vibration and air overpressure at locations specified herein.

B. The **Contractor** is expressly advised that the protection of buildings, structures, roads, bridges, and related work adjacent and in the vicinity of its operations, wherever they may be, is solely their responsibility. Condition inspection of buildings, bridges or other structures shall be performed by and be the responsibility of the **Contractor**.

C. Repairs or replacement of all conditions disturbed by the Work shall be made to the satisfaction of the owners or agents of adjacent buildings, structures, roads, facilities, etc., and to the satisfaction of the **Owner**. This does not preclude conforming to the requirements of the insurance underwriters. Three (3) copies of surveys, photographs, videos, reports, etc., shall be given to the **Owner** prior to the commencement of any construction-related activities.

D. Perform a preconstruction video survey and inspection in advance of construction to document the existing condition of buildings, facilities, structures, utilities, roads, driveways, and related work.

E. Video survey and inspection of buildings, structures, facilities, utilities and related work in the immediate vicinity of the water reclamation facility site, lift station site and along the entire length of the conveyance pipeline and access roads used by heavy trucks and construction equipment shall be performed by the specialist. The video surveys and inspections shall clearly document the existing conditions and be completed before any operations have begun and subject areas disturbed by any construction activities. The video surveys and inspection notes, reports, etc. shall be submitted to the **Owner**. The video surveys and inspections shall make an examination of the interior and exterior of buildings, structures, facilities and utilities, and record by notes, measurements, photographs, videos, etc., conditions which might be aggravated by construction activities. Prior to blasting, video surveys and inspections of residences and other private structures existing within the immediate vicinity of the construction sites shall have been completed.

F. The cost of all pre-construction and post-construction video surveys and inspections shall be borne by the **Contractor**.

1.02 RELATED SECTIONS

A. Section 01380 – Photographic Documentation

B. Section 02140 – Dewatering

C. Section 02405 – Blasting.

1.03 SUBMITTALS

A. The **Contractor** shall submit pre- and post-construction inspection reports and baseline noise, vibration and air overpressure surveys as described in Part 3 of this Section.

B. The **Contractor** shall submit pre- and post-construction survey reports and measurements for dewatering efforts as described in Part 3 of this Section and in **Section 02140 - Dewatering.**

C. All pre-construction inspection reports and baseline noise, vibration and air overpressure surveys shall be submitted to the **Owner** at least four (4) weeks prior to commencement of excavation by means of explosives and blasting.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 INSPECTION

A. Prior to the start of any construction by means of blasting and explosives, the **Contractor** shall conduct pre-construction video surveys and inspections as well as noise, vibration and air overpressure surveys as follows:

1. Blasting: Perform pre-construction video survey and inspections for all structures, houses, utilities and other facilities located:

   a. Entirely or partially within 200 feet each side of centerline (projected to ground surface) for conveyance pipelines where blasting will be done (or as described in Item d below, whichever is greater).

   b. Entirely or partially within a 1,000-foot radius from the center of each lift station site where blasting will be done (or as described in Item d

below, whichever is greater).

c. In addition to the above, any structures where the **Contractor**'s blast expert expects peak particle velocities to exceed 0.2 inches per second based on estimation from empirical relationships.

d. Perform preconstruction inspection of properties within a scaled distance of 75 ft./lb½ from the blasting perimeter. For example, if the maximum charge weight per delay is ten (10) pounds, the survey distance would be 237 feet (or (75 ft./lb½) x (10 pounds) ½).

B. For all noise, vibration and air overpressure surveys:

1. Pre-construction noise, vibration and air overpressure surveys shall be undertaken by the **Contractor**'s approved Consultant. The baseline surveys shall be performed 24 hours a day for a 2-week period in order to determine the baseline readings. The baseline surveys shall be determined at the following locations with the actual location of the instruments determined in the field by the **Contractor** and the **Owner**:

   a. Three locations for each location of blasting along the construction of the conveyance pipelines.

   b. Three locations at the Wani Road Lift Station Site

2. All instruments shall be purchased by the **Contractor** and maintained on site for the duration of the Work as well as a period of 3 months after the Work is complete. The **Contractor** shall protect all instruments and appurtenant fixtures, leads, connections, and other components of the instrumentation systems from damage due to construction operations, weather, traffic, and vandalism. If an instrument is damaged or inoperative, the **Contractor**'s instrumentation personnel shall repair or replace the damaged or inoperative instrument within 72 hours at no additional cost to the City. The **Contractor** shall notify the **Owner** at least 24 hours prior to repairing or replacing a damaged or inoperative instrument. The **Owner** will be the sole judge of whether repair or replacement is required.

3. All instruments shall be grounded and shall incorporate data recorders to enable continuous readings for data collection and downloading.

4. The **Contractor** shall prepare and deliver to the **Owner** at least two (2) weeks prior to the start of construction at each location, three (3) DVD format of all ambient noise, vibration, and air overpressure baseline readings including readings in Excel spreadsheet format and three (3) bound copies of each of the data readings.

C. Prior to any construction activities requiring dewatering efforts, the **Contractor** shall conduct pre-construction surveys of settlement benchmark elevations at and around existing structures, buildings, and other features as follows:

1. As outlined in the requirements for pre-construction surveys as described herein this specification.

2. As outlined in the requirements described in **Section 02140 - Dewatering**.

D. Upon completion of any construction activities requiring dewatering efforts, the **Contractor** shall conduct post-construction surveys of settlement benchmark elevations at and around existing structures, buildings, and other features as follows:

1. As outlined in the requirements for post-construction surveys as described herein this specification.

2. As outlined in the requirements described in **Section 02140 - Dewatering**.

E. For all pre-construction surveys:

1. Pre-construction video surveys and inspections shall be undertaken by qualified specialists/consultant, approved by the **Owner** and the **Contractor**'s insurance carrier retained for this purpose by the **Contractor** to observe the condition of existing structures, utilities, and facilities in the vicinity of the Work at required intervals. The pre-construction video surveys and inspections shall thoroughly document all existing damage or defects to both the interior and exterior of all structures, houses, buildings, roads, or facilities. The interior conditions of all portions of all structures, including all walls, partitions, floors and ceilings shall be thoroughly documented by diagrams, transcribed notes, videos and photographs to show the location and extent of existing damage deterioration and cracks including their dimensions, extent, and other relevant features. A video and a minimum of ten (10) interior and thirty (30) exterior photographs shall be taken for each structure or facility. Close-up, video and detailed color photographs shall be taken of all cracks, deterioration and other observable defects in the exterior portions of all buildings and other property improvements including, but not limited to, retaining walls, driveways and sidewalks. The size of all color photographic prints shall be 4-inches by 6 inches, minimum.

2. The **Contractor** shall prepare and deliver to the **Owner** at least two (2) weeks prior to the start of construction at each site, three (3) digital video on in .mpeg format of his pre-construction inspections containing all field

notes taken , sketches and diagrams prepared, color prints produced from negatives or from digital files of all photographs obtained together with a schematic plan indicating where photographs were taken, descriptions and reports, all signed and witnessed by those taking part in the inspection. The Owner will, upon request, present one of these copies to the property owner or responsible party for each property or utility affected. **Contractor** shall re-inspect all homes and structures where owners claim that damage is occurring as a result of the **Contractor**'s blasting, tunneling and/ or construction operation. Three (3) copies of all data obtained by the **Contractor** from each re-inspection shall be promptly (within three days of re-inspection) delivered to the **Owner**. The Owner will, upon request, present one of the submitted copies to the property owner or responsible party for each property or utility affected.

F. Nothing contained herein shall relieve the **Contractor** of responsibility for claims arising from his construction operations. Failure to inspect any structure, whether or not required by these Contract Documents or inadequacy of the inspections shall not relieve the **Contractor** of his responsibility. The **Contractor**'s shall indemnify the Owner from such claims. The **Contractor** shall engage the services of an experienced, independent, licensed Engineer to evaluate any claims that may arise as a result of blasting, tunneling and/or construction operations. The Engineer may reject the claims specialist, if the Engineer has reason to believe that there exists material ownership interests between the claims specialist and the **Contractor** and/or blasting consultant, and/or the vibration specialist, and/ or there exists relationships among the aforementioned entities, or for other reasons.

G. In the event that any property owner denies access for the survey of structures and facilities within the specified limits, the **Contractor** shall notify such property owner, by certified mail, on the intent of the survey. If after two (2) weeks, access is still denied, the **Contractor** shall notify the property owner once again by certified mail, stating that this is final notification and work will commence within seven days. Submit to the Owner copies of all correspondence between the **Contractor** and the property owner(s). The Owner, upon review of the submitted correspondence may waive requirements set forth in Paragraph A and B in this Article. However, the **Contractor** is fully responsible for claims and damage arising from his construction operation regardless of property location.

H. For all post-construction surveys:

1. Post-construction inspections shall be undertaken by qualified specialist, approved by the **Owner** and the **Contractor**'s insurance carrier retained for this purpose by the **Contractor** to observe the condition of existing structures, utilities, roads, and facilities in the vicinity of the Work within 30

days of the completion of any section of work that includes blasting or tunneling activities. The post-construction inspections shall thoroughly document the condition of the interior and exterior of all structures, houses, buildings or facilities. To facilitate the inspection, use shall be made of the pre-construction inspection to identify any changes in condition. Photographs and videos of all items noted in the pre-construction inspection shall be taken from the same locations. Any damage noted that was not included in the pre-construction inspection shall be thoroughly documented by diagrams, transcribed notes, videos and photographs to show the location and extent of damage deterioration and cracks including their dimensions, extent, and other relevant features. Close-up, videos and detailed color photographs shall be taken of all cracks, deterioration and other observable defects in the exterior portions of all buildings and other properly improvements including, but not limited to, retaining walls, driveways and sidewalks. The size of all color photographic prints shall be 4 inches by 6 inches, minimum.

2. The **Contractor** shall prepare and deliver to the **Owner**, within 14 days of undertaking the inspection, three (3) digital video in mpeg formatof all photographs obtained together with a schematic plan indicating where photographs were taken, descriptions and reports indicating whether any additional damage has been observed or if previously identified defects have become worse, all signed and witnessed by those taking part in the inspection. The Owner will, upon request, present one of these copies to the property owner or responsible party for each property or utility affected.

I. For digital photography a minimum 10-megapixel camera shall be used. Submit all digital files to Owner in jpeg format..

+++ END OF SECTION 01714

SECTION 01880
LIQUID TIGHTNESS TEST
FOR CONCRETE STRUCTURES

PART 1 – GENERAL

1.01 SCOPE

A. This Section is a supplement to **Section 03300 - Cast-in-Place Concrete**. This Section specifies the additional acceptance testing requirements for open or covered environmental, liquid containment structures designed in accordance with ACI 350.

B. The following structures are required to meet the additional acceptance testing requirements for liquid tightness as specified herein:

1. Wani Road Lift Station - Wet Well Structure

C. Furnish labor, material, equipment, and incidental items necessary to complete the Work.

D. The latest edition of ACI 350.1 shall be the base specification in conjunction with the additions and modifications as noted herein. ACI 350.1 requirements related to the Work shall apply whether or not they are referenced herein. In case of conflict, the more stringent requirement shall apply.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):

a. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.

b. 350.1, Tightness Testing of Environmental Engineering Concrete Structures – Specification.

1.03 TESTING REQUIREMENTS

A. The hydrostatic tightness test for containment structures shall consist of two Parts.

1. Part 1 – Qualitative Criterion: The visual observation and identification of water loss and the repair of identified areas that leak.

2. Part 2 – Quantitative Criterion: The measured and calculated results for water loss and the identification and repair of areas that leak. The quantitative criterion for acceptance is as follows:

a. All concrete structures specified herein: 0.050% of volume per day.

1.04 SUBMITTALS

A. Repair Procedures: Submit all repair procedures including the following:

1. Methods, materials, and locations of modifications to the containment structure.

2. Product data and manufacturer's installation procedures for all repair products used to repair leaks.

B. Test Reports: Submit test reports of results of tightness testing. Include a detailed description of the following:

1. Test locations and methods of measuring water level.

2. Initial and final water elevation measurements.

3. Amounts of precipitation or evaporation.

4. Measured ambient air and water temperatures.

5. Volume corrections.

6. Retest results and corrective actions taken.

7. Final results of successful test completion.

PART 2 – PRODUCTS

2.01 WATER

A. Water used for hydrostatic tightness testing shall be potable water complying with ASTM C94.

PART 3 – EXECUTION

3.01 TEST PREPARATION

A. Clean exposed concrete surfaces of the containment structure of foreign material and debris to allow for visual examination of the concrete surfaces for areas of potential leakage.
B. Remove standing water in or outside of the containment structure that would interfere with the visual examination of the exposed concrete surfaces of the containment structure.

C. Visually examine concrete surfaces and concrete joints for potential leakage. Repair areas of potential leakage before filling the containment structure with water.

D. Unless permitted by the **Owner**, do not apply any coatings, inside or outside, until after the hydrostatic tightness testing has been completed.

E. Visually examine all openings, fittings, and pipe penetrations in the containment structure. Seal all penetrations, including inlets and outlets, to prevent the addition or loss of water in the containment structure during the test. Repair leakage observed at these locations before Part 2 test measurements are taken.

F. Continue dewatering as required to keep groundwater levels lowered around the containment structure during Parts 1 and 2 of the test.

G. Unless permitted by the **Owner**, do not place backfill against the walls or on top of footings of the containment structure until after the hydrostatic tightness testing has been completed.

H. The containment structure shall be filled with water as follows:

1. Do not exceed a rate of 4 ft/hr for the initial filling.

2. Fill the containment structure to within 1 inch of the high-water elevation indicated on the Drawings.

3. Keep the containment structure full for at least 3 days (Part 1) before proceeding to Part 2 of the test.

3.02 HYDROSTATIC TIGHTNESS TEST – PART 1 (QUALITATIVE CRITERIA)

A. Part 1 of the hydrostatic tightness test shall last a minimum of 3 days before proceeding to Part 2 of the test.

B. Part 1 of the test will be considered to have failed if any water is visibly leaking or where moisture is accumulating on the containment structure exterior surfaces, including joints, and repaired honeycombed areas and cracks.

1. Wet areas on top of footings does not signify a failure of Part 1 unless the water is visibly flowing.

C. Observe the exterior surfaces of the containment structure in the early mornings and late afternoons with a minimum interval of 6 hours between observations during the 3-day period of Part 1 testing.

D. Part 2 of the test may begin prior to completion of repairs for Part 1. Repairs of all defects causing the failure of Part 1 must be completed before final acceptance of the containment structure.

3.03 HYDROSTATIC TIGHTNESS TEST - PART 2 (QUANTITATIVE CRITERIA)

A. Do not schedule Part 2 of the hydrostatic tightness test when the difference in ambient temperature will vary by 35 degrees Fahrenheit or more between the times the initial and final level measurements of the water surface will be taken.

B. Do not schedule Part 2 of the hydrostatic tightness test when the water surface could freeze before the test is completed.

C. Measure the vertical distance to the water surface to within 1/16 in. from a fixed point on the containment structure above the water surface. Record measurements at 24-hour intervals.

D. The test period shall be as follows:

    1. No Measurable Loss Criterion: 72 hours

    2. Other Criterion: The test period shall last the theoretical time required to lower the water surface by 3/8 inches assuming a loss of water at the maximum allowable rate. The test period shall not last longer than 5 days.

E. Record the water temperature at a depth of 18 inches below the water surface level at the start and end of the test. Include volume corrections for temperature differences.

F. Measure evaporation and precipitation in uncovered containment structures.

G. Record the water surface level to within 1/16 inch at the end of the test period at the location of the original measurements.

H. Observe the containment structures during early mornings and late evenings with a minimum interval of 6 hours between observations to verify compliance of Part 1 during Part 2 of the hydrostatic test.

I. Calculate and correct changes in water volume in the containment structure for evaporation, precipitation, and temperature. If volume loss exceeds the required limits, the containment structure fails Part 2 and must be repaired and retested.

3.04 RETESTING

A. Retest the containment structures until they meet the criteria of Part 1 and Part 2. Make repairs before each retest attempt.
B. Once Part 1 is passed, Part 1 will not be required to be retested if Part 2 of the test fails. It is permitted to immediately retest a containment structure failing Part 2 once Part 1 has passed.

C. When the test results for Part 2 become unreliable due to unusual precipitation, leaking inlet or effluent pipe plugs, or other external factors; Part 2 of the hydrostatic test shall be restarted.

D. Retest the containment structure only after the probable problem areas are identified and repaired.

+++ END OF SECTION 01880 +++

SECTION 01880
LIQUID TIGHTNESS TEST
FOR STEEL TANKS

PART 1 – GENERAL

1.01 SCOPE

A. This Section specifies the additional acceptance testing requirements for open or covered environmental, liquid containment structures constructed of steel.

B. The following structures are required to meet the additional acceptance testing requirements for liquid tightness as specified herein:

1. Headworks Structure

2. Splitter Box

3. Aeration Basins (3)

4. Secondary Clarifiers (2)

5. Aerobic Digester

C. Furnish labor, material, equipment, and incidental items necessary to complete the Work.

D. The latest edition of AWWA Standard D101-53(R79) shall be the base specification in conjunction with the additions and modifications as noted herein. In case of conflict, the more stringent requirement shall apply.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

a. D100-21(latest revision) AWWA Standard for Welded Carbon Steel Tanks for Water Storage

b. D101-53(R79) AWWA Standard for Inspecting and Repairing Steel Water Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage

1.03 TESTING REQUIREMENTS

A. The hydrostatic tightness test for containment structures shall consist of two Parts.

1. Part 1 – Qualitative Criterion: The visual observation and identification of water loss and the repair of identified areas that leak.

2. Part 2 – Quantitative Criterion: The measured and calculated results for water loss and the identification and repair of areas that leak. The quantitative criterion for acceptance is as follows:

a. All steel structures specified herein: 0.050% of volume per day.

1.04 SUBMITTALS

A. Repair Procedures: Submit all repair procedures including the following:

1. Methods, materials, and locations of modifications to the containment structure.

2. Product data and manufacturer's installation procedures for all repair products used to repair leaks.

B. Test Reports: Submit test reports of results of tightness testing. Include a detailed description of the following:

1. Test locations and methods of measuring water level.

2. Initial and final water elevation measurements.

3. Amounts of precipitation or evaporation.

4. Measured ambient air and water temperatures.

5. Volume corrections.

6. Retest results and corrective actions taken.

7. Final results of successful test completion.

PART 2 – PRODUCTS

2.01 WATER

A. Water used for hydrostatic tightness testing shall be potable water shall be potable water from a municipal water system.
B. Or water from Cabin Creek. Water taken from Cabin Creek must be taken from SCWA property and after written or email permission from the **Owner**.

PART 3 – EXECUTION

3.01 TEST PREPARATION

A. Clean exposed painted steel surfaces of the containment structure of foreign material and debris to allow for visual examination of the surfaces for areas of potential leakage.
B. Remove standing water in or outside of the containment structure that would interfere with the visual examination of the exposed surfaces of the containment structure.

C. Visually examine steel surfaces and penetrations for potential leakage. Repair areas of potential leakage before filling the containment structure with water.

D. Unless permitted by the **Owner**, do not apply any coatings, inside or outside, until after the hydrostatic tightness testing has been completed.

E. Visually examine all openings, fittings, and pipe penetrations in the containment structure. Seal all penetrations, including inlets and outlets, to prevent the addition or loss of water in the containment structure during the

test. Repair leakage observed at these locations before Part 2 test measurements are taken.

F. Continue dewatering as required to keep groundwater levels lowered around the containment structure during Parts 1 and 2 of the test.

G. Unless permitted by the **Owner**, do not place backfill against the walls or on top of footings of the containment structure until after the hydrostatic tightness testing has been completed.

H. The containment structure shall be filled with water as follows:

1. Fill the containment structure to within 1 inch of the high-water elevation indicated on the Drawings.

2. Keep the containment structure full for at least 5 hours (Part 1) before proceeding to Part 2 of the test.

3.02 HYDROSTATIC TIGHTNESS TEST – PART 1 (QUALITATIVE CRITERIA)

A. Part 1 of the hydrostatic tightness test shall last a minimum of 4 hours before proceeding to Part 2 of the test.

B. Part 1 of the test will be considered to have failed if any water is visibly leaking or where moisture is accumulating on the containment structure exterior surfaces, including joints, and repaired honeycombed areas and cracks.

1. Wet areas on top of footings does not signify a failure of Part 1 unless the water is visibly flowing.

C. Observe the exterior surfaces of the containment structure with a minimum interval of 1 hour between observations during the 4-hour period of Part 1 testing.

D. Part 2 of the test may begin prior to completion of repairs for Part 1. Repairs of all defects causing the failure of Part 1 must be completed before final acceptance of the containment structure.

3.03 HYDROSTATIC TIGHTNESS TEST - PART 2 (QUANTITATIVE CRITERIA)

A. Do not schedule Part 2 of the hydrostatic tightness test when the difference in ambient temperature will vary by 35 degrees Fahrenheit or more between the times the initial and final level measurements of the water surface will be taken.

B. Do not schedule Part 2 of the hydrostatic tightness test when the water surface could freeze before the test is completed.

C. Measure the vertical distance to the water surface to within 1/16 in. from a fixed point on the containment structure above the water surface. Record measurements at approximately 8 to 12 hour intervals (9 am, 3 pm, 9 am).

D. The test period shall be as follows:

   1. No Measurable Loss Criterion: 24 hours

   2. Other Criterion: The test period shall last the theoretical time required to lower the water surface by 3/8 inches assuming a loss of water at the maximum allowable rate. The test period shall not last longer than 24 hours.

E. Record the water temperature at a depth of 18 inches below the water surface level at the start and end of the test. Include volume corrections for temperature differences.

F. Measure evaporation and precipitation in uncovered containment structures.

G. Record the water surface level to within 1/16 inch at the end of the test period at the location of the original measurements.

H. Observe the containment structures during early mornings and late evenings with a minimum interval of 6 hours between observations to verify compliance of Part 1 during Part 2 of the hydrostatic test.

I. Calculate and correct changes in water volume in the containment structure for evaporation, precipitation, and temperature. If volume loss exceeds the required limits, the containment structure fails Part 2 and must be repaired and retested.

3.04 RETESTING

A. Retest the containment structures until they meet the criteria of Part 1 and Part 2. Make repairs before each retest attempt.
B. Once Part 1 is passed, Part 1 will not be required to be retested if Part 2 of the test fails. It is permitted to immediately retest a containment structure failing Part 2 once Part 1 has passed.

C. When the test results for Part 2 become unreliable due to unusual precipitation, leaking inlet or effluent pipe plugs, or other external factors; Part 2 of the hydrostatic test shall be restarted.

D. Retest the containment structure only after the probable problem areas are identified and repaired.

+++ END OF SECTION 01890 +++

SECTION 02000
SITE WORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. These general site work requirements apply to all site work operations. Refer to specification sections for specific product and execution requirements.

1.02 QUALITY ASSURANCE

A. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.

B. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

1.03 PROJECT CONDITIONS

A. 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.

B. Arrange for disconnection and seal or cap all utilities and services designated to be removed before the start of site work operations. Perform all work in accordance with the requirements of the applicable utility company or agency involved.

C. 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.

D. Locate, protect, and maintain benchmarks, monuments, control points and project engineering reference points. Reestablish disturbed or destroyed items at **Contractor's** expense.

E. Perform site work operations and the removal of debris and waste materials to assure minimum interference with streets, walks, and other adjacent facilities.

F. 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.

G. Control dust caused by work. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

H. 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.

I. Protect and maintain streetlights, 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 mailboxes with the applicable governmental agency. Provide temporary relocation when required to maintain facilities and services in operation during construction work.

J. Preserve from injury or defacement all vegetation and objects designated to remain.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment: As selected by **Contractor**, except as indicated in contract documents.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine the areas and conditions under which site work is performed. Do not proceed with the work until unsatisfactory conditions are corrected.

B. Consult the records and drawings of adjacent work and of existing services and utilities which may affect site work operations.

+++ END OF SECTION 02000 +++

SECTION 02020
USE OF EXPLOSIVES

PART 1 - GENERAL

1.01 SCOPE

A. This section covers the use of explosives and blasting. Limit the use of explosives in the work to the practicable minimum by utilizing mechanical means of excavation to the maximum feasible extent. Blasting shall be limited and shall be approved by the **Owner**.

No Blasting shall occur until the Contractor has received written approval from Owner. The Contractor shall notify Owner in writing the date, time of day of the first blast and the duration the blasting is to occur.

B. Related Work Specified Elsewhere:

1. Section 02000 - Site Work
2. Section 02140 - Dewatering
3. Section 02200 - Earthwork
4. Section 02324 - Trenching and Trench Backfill

C. Definitions:

Controlled blasting is excavation of rock in which the blast hole size, spacing, depth and burden, and the charge size, depth and delay sequence are carefully planned and controlled to excavate the rock to the required limits. Controlled blasting minimizes overbreak and fracturing of the rock beyond the design lines.

1.02 GENERAL

A. Perform blasting only with permits from the appropriate jurisdictional agencies. Necessary permits include an Explosives License issued by the Georgia Safety Fire Commissioner, and users' permits obtained from **Spalding County**. Obey all local, State, Federal and other Governmental regulations applying to transportation, handling, storage and use of explosives, including the requirements of the Spalding County Fire Department, the State of Georgia and applicable regulations of the Occupational Safety and Health Administration.

B. Perform blasting operations in trenches, shafts and other open excavations only during daylight hours. Perform blasting operations only during the hours approved by the **Owner**. No blasting shall be performed on Saturdays,

Sundays or on the public holidays observed by the **Owner**. If an emergency prevents a blast being fired during the permitted hours and the holes are loaded, the blast shall be fired as soon as safety allows. In the event that blasting is found necessary outside the permitted hours, the **Contractor** shall receive approval from the **Owner** and inform local residents within hearing and vibration range and the jurisdictional agencies prior to firing.

C. Furnish, install and operate at each site where blasting is being performed, using electric methods of initiation, an approved short-range, high accuracy thunderstorm monitor and lightning warning system. System shall constantly be monitoring the electrical field of the atmosphere for pre-emptive notification of nearby lightning strikes. The system shall connect to system lighting and audible devices to alert of incoming lightning activity. The system shall have the capability to send test messages and email alert notifications. The system shall have adequate provisions for transmitting alarms from the device to all locations where preparation for blasting, using electric initiation, are in progress. Install and maintain the system in accordance with the manufacturer's recommendations. Test the entire monitoring and alarm system for satisfactory operation at intervals not exceeding two (2) weeks and suspend blasting operations until any defects have been corrected.

D. Employ the services of a blasting consultant, satisfactory to the **Owner** and experienced in predicting and evaluating the effects of blasting on nearby structures, such that vibration levels at these structures do not exceed a level that will damage the structures or their contents or cause undue alarm to their occupants. Employ the blasting consultant to plan and evaluate blasting operations.

E. Preconstruction Video Survey and Inspections

1. **Contractor** is expressly advised that the protection of buildings, structures, bridges, utilities, and related work adjacent and in the vicinity of its operations, wherever they may be, is solely its responsibility. Existing condition inspection of buildings, bridges or other structures in the immediate vicinity of any blasting operations shall be performed by and be the responsibility of the **Contractor**. The inspection corridor shall extend within a 500-foot radius of all proposed blasting operations. The **Contractor** shall retain an independent consultant, specializing in preconstruction surveys, to conduct the required inspections. The video survey and inspections shall conform to the requirements of **Section 01380 - Photographic Documentation**.

2. Prior to the start of blasting operations, the **Contractor** shall have the independent preconstruction survey consultant, make an examination of the interior and exterior of the adjacent structures, buildings, facilities, etc., and record by notes, measurements, photographs, etc., conditions which might be aggravated by blasting or other operations.

Repairs or replacement of all conditions disturbed by the construction shall be made to the satisfaction of the owners or agents of adjacent buildings, structures, facilities, etc., and to the satisfaction of the **Owner**. This does not preclude conforming to the requirements of the insurance underwriters. Two (2) copies of surveys, photographs, videos, reports, etc., shall be submitted to the **Owner**.

3. The cost of all pre-construction video surveys and inspections shall be borne by the **Contractor**.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of **Section 01300 - Submittals**. In addition, the following specific information shall be provided:

1. At least sixty (60) days prior to commencement of blasting operations, a copy of all applicable licenses and permits for the purchase, transportation, storage and use of explosives.

2. At least sixty (60) days prior to commencement of blasting operations, a Blasting Monitoring Plan that shall include:

   a. Name of the Blasting Vibration Consultant who shall be responsible for establishing the monitoring program and interpreting the vibration readings;

   b. Names of the trained personnel provided to operate the monitoring equipment; the type and model of blasting seismograph proposed for use;

   c. Number and location of proposed monitoring stations; the methods to be used to coordinate blast detonation with recording of the blast; and

   d. Steps to be taken if blasting vibrations exceed or seem likely to exceed the vibration limits.

   e. Name, make, and model of the short-range, high accuracy thunderstorm monitor and lightning warning system, including details on the alert warning system.

3. At least sixty (60) days prior to any blasting operation, provide:

   a. Initial blast design for that location including number, location, diameter, depth and inclination of drill holes on a scale drawing of the excavation or heading face;

   b. Type and weight of explosive in each hole; delay arrangement

showing delay period in each hole; total weight of explosive in the blast and maximum charge per delay; the method of detonation; calculations of peak particle velocities and air blast overpressures; and the precautions to be taken to prevent flying rock or other debris.

c. Manufacturers' data sheets shall be provided for all explosives and accessories to be used.

d. Name and qualifications of the independent preconstruction survey consultant.

e. Preconstruction Video Survey and Inspections.

f. Written controlled blasting techniques.

4. At least thirty (30) days prior to any blasting operation, provide Blasting Safety Plan including:

a. Health and Safety requirements of all governing legislation;

b. Certificates from all regulating agencies and relevant insurance companies;

c. Outline of safety training program for the **Contractor**'s and **Owner's** personnel;

d. Communication and warning procedures;

e. Samples of all report and inspection forms; and lightning protection plan.

5. Within the working day following each blast, the **Contractor** shall provide the blasting records and information for each blast detonated:

a. A complete description including the location, date and exact time of the blast; name and signature of person in responsible charge of loading and firing and their blaster permit number; details of each blast as listed above for the initial blast design and any departures from the blast design; comments regarding any misfires, unusual results or unusual effects; any other records required by applicable regulations; and the name and signature of the person preparing the report.

b. The monitoring record including the location, date, and exact time of the blast; general weather conditions; the locations of seismographs and type of ground on which they were located, instrument identification and their distances from the blast; the measured peak particle velocities; air blast overpressure records,

if appropriate; and the name and signature of the observer.

1.04 QUALITY ASSURANCE

Work Experience:

A. The blasting consultant shall have at least ten (10) years of blasting experience. The blasting consultant shall be on call throughout the entire period that blasting is performed and shall be available at the site within two (2) days at any time that the blasting consultant's services may be necessary as determined by the **Owner**.

B. Blasting supervisors shall have a minimum of five (5) years' experience in supervising the loading and firing of charges for the excavation of shafts and trenches and shall have all necessary licenses and permits required by the appropriate jurisdictional agencies.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Use only non-nitroglycerine explosives.

B. Store explosives and detonators in the manufacturers' boxes with date codes to allow the **Owner** to determine their age of the materials. All explosives and detonators used in the work shall be less than one (1) year old. Blasting products shall not be brought onto the site if the date codes are missing. When in the **Owner's** opinion any blasting product is either of excessive age or in a deteriorated condition, that material shall not be used until its age or quality can be shown to be satisfactory.

2.02 EQUIPMENT

A. Use dust suppressant measures with air-powered or air-flush rock drilling equipment.

B. Wet down the muck pile after blasting to control dust during mucking operations.

PART 3 - EXECUTION

3.01 GENERAL

A. Firing shall be permitted only after the proper precautions have been taken for the protection of all persons, work, and property.

B. The following limits on peak particle velocities and air blast overpressure, or such lower limits as established by the **Contractor's** Blasting Vibration Consultant, shall apply:

1. At structures and utilities in the vicinity of blasting operations, the peak particle velocity resulting from blasting shall not exceed:

    a. Frequency < 3 Hz: 0.2 inches/second.

    b. Frequency 3 - 10 Hz: 0.5 inches/second.

    c. Frequency 10 - 40 Hz: varying linearly 0.5 to 1.0 inches/second.

    d. Frequency > 40 Hz: 1.0 inches/second.

    The above limits are adopted from modified blasting level criteria given in U.S. Bureau of Mines Recommendations RI-8507.

2. In the permanent concrete work, the peak particle velocities resulting from blasting shall not exceed two (2) inches per second.

3. At the nearest structure subject to damage from air blast overpressure, the mean peak air blast overpressure shall not exceed 0.01 psi. Measure readings for peak particle velocity in three (3) orthogonal directions by equipment approved by the **Owner** that is either continually recording or triggered by a preset level of vibration. Determine particle velocity in each frequency range by spectral analysis. Zero crossing method to determine frequency is not acceptable.

C. Blasting within fifty (50) feet of permanent concrete work may be permitted only after approval of the **Contractor's** plans showing the relative positions of the concrete, the area to be blasted and the blasting technique to be employed. All concrete work shall be protected by limiting the size of blasts, covering blasts and by other means until it is established that there is no danger of damage caused by either vibration or flying rock.

D. Exercise all possible care in drilling and blasting operations to ensure the stability of the remaining rock and to keep overbreak to a minimum. Written controlled blasting techniques to be used shall be submitted to the **Owner** for approval.

E. At each work site where blasting is being performed, erect signboards of adequate size stating that blasting operations are taking place in the work site and such signs shall be clearly visible at all points of access to the work site.

F. Monitor the first blast at each location as a test case and modify the initial blast design for that location if the monitoring record indicates that the vibration and air blast overpressure limits were exceeded or may be exceeded in subsequent blasts. Resubmit the blast design to the **Owner**. Continue vibration recording and air blast overpressure monitoring for every blast, and further adjustments to the blast design shall be made when the records

indicate vibration or air blast overpressure in excess of the established limits.

G. Before the firing of any blast where flying material may result in damage to persons, property, or the work, cover the rock to be blasted with suitable matting and overburden to prevent flying debris. After a blast is fired, remove all loose and shattered rock or other loose material that may endanger the structure or the workers, and make the excavation safe before continuing with the work. Carry out similar checks on previously excavated sections at least every 48 hours and recheck the support system, tightening lagging, and blocking, and adding rock dowels, mesh and other support measures as required. Before drilling new blast holes, thoroughly clean the face and examine the face for holes containing undetonated explosive.

H. In the event that damage occurs due to blasting work, suspend all blasting immediately and make a report to the **Owner**. Before resuming blasting, adjust the blast design and resubmit it to the **Owner**, and take any other appropriate measures to control the effects of blasting.

I. If blasting causes excessive overbreak or excessive fracturing of the surrounding rock, or is otherwise detrimental to the work, modify the blast design as necessary to achieve the desired result, and resubmit it to the **Owner**.

+++ END OF SECTION 02020 +++

SECTION 02050
DEMOLITION

PART 1 - GENERAL

1.01 SCOPE

A. General:

1. This section covers the labor, equipment, and materials necessary for the work associated with the demolition or removal of pipes, manholes, catch basins, pavement, houses, and other structures within the construction easements shown on the Plans, including all necessary excavation and backfilling.

2. Where removing structural tile and brick from existing structures, the work shall include all patching and reconditioning to restore the remaining tile or brick to its existing state and to provide a proper joint for joining the existing to new construction.

3. Where concrete is cut from existing structures under this Section to permit setting or inserting pipes, flumes, equipment or appurtenances, the work shall include all re-concreting, dressing and finishing of openings to the required lines and dimensions or as necessary for the placing and fixing of inserts. This repair is to meet all structural and leakage requirements and shall use non – shrink material.

4. The **Contractor** shall remove from existing structures and salvage, store or dispose of as specified hereinafter, all valves and piping, mechanical equipment, plumbing, heating, electrical, and ventilating fixtures, pipes, ducts, wires, and equipment, doors and windows, floor grating and cover plates, steel stairs, pipe railing, and the like that are not to remain in service in the finished work, whether or not shown on the Drawings and/or specified herein.

5. The work specified herein and shown in the Drawings is intended to give a general idea of the scope of this work but shall not be construed as covering it entirely. The **Contractor** shall visit the site and judge the amount of work required and the problems anticipated in the performance of the work.

6. Requirements for removal and abandonment of site utilities are specified in **Section 02000 - Site Work**.

B. Related Work Specified Elsewhere:

1. Section 02000 - Site Work

2. Section 02200 – Earthwork

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of **Section - 01300 Submittals**. In addition, the following specific information shall be provided:

1. The **Contractor** shall submit to the **Owner** a schedule of demolition, detailed methods of demolition to be used for each structure, copies of authorization, and permits to demolish the structures.

PART 2 - PRODUCTS

2.01 GENERAL

A. The **Contractor** shall provide all materials and equipment in suitable and adequate quantities as required to accomplish demolition work.

PART 3 - EXECUTION

3.01 SAFETY REQUIREMENTS

A. All work shall be performed in conformance with the laws and regulations pertaining to safety established by Federal, State, and local governments and other authorities having jurisdiction.

3.02 UTILITIES

A. The **Contractor** shall be responsible for maintaining all appropriate utility services during the demolition operations.

B. Sewer lines shall be removed or grouted for their entire lengths and plugged at both ends with concrete to prevent groundwater infiltrating into the sewer line.

C. Total shutdown of the existing utilities to perform any new construction, to make the required structural or piping modifications, and/or to make or install the required service or system modifications, shall not be permitted, except by written request and approval of the **Owner**.

D. Prior to making any piping or connections or modifications to existing facilities, the **Contractor** shall obtain specified timing and schedule approval from the **Owner**.

3.03 REMOVAL AND STORAGE OF EQUIPMENT FOR REUSE

A. No structure shall be removed without the approval and consent of the **Owner** unless shown on the Plans to be removed. The **Contractor** shall maintain all equipment in the same condition as when it was removed. The condition of the structure shall be

determined prior to removal by the **Owner**. The **Contractor** assumes the responsibility for assuring that the material is properly stored and maintained.

3.04 DEMOLITION

A. The Plans define the portion of the structures to be removed. Unless otherwise shown on the Plans, the **Contractor** shall not make rough cuts or breaks that exceed the limits of demolition shown.

B. All equipment, materials, and piping, except as specified hereinbefore, within the limits of the demolition shall become the property of the **Contractor**.

3.05 REMOVAL OF EXISTING PIPING

A. Where existing piping is in conflict with new piping or construction, rerouting or redesign shall be as directed by the **Owner**.

3.06 BACKFILLING

A. The **Contractor** shall backfill all demolished areas to existing ground level as to create positive sheet runoff.

B. Backfill material shall meet the minimum requirements of **Section 02200 - Earthwork**. Backfill compaction shall be in accordance with the applicable requirements of **Section 02324 - Trenching and Trench Backfilling**. Rock and debris shall not be used as backfill material. In all areas not backfilled to ground level, the **Contractor** shall erect safety barriers around the excavation and not allow water to accumulate.

3.07 DISPOSAL OF DEMOLITION DEBRIS

A. The **Contractor** shall dispose of demolition debris in accordance with the requirements of **Section 02000 - Site Work**.

+++ END OF SECTION 02050 +++

SECTION 02060
CRUSHED STONE AGGREGATE

PART 1 - GENERAL

1.01 SCOPE

A. This section includes installation of crushed stone aggregate; and any other similar, incidental, or appurtenant operation that may be necessary to properly complete the Work.

B. The **Contractor** shall provide all services, labor, materials, and equipment required for all installation of crushed stone aggregate and related operations necessary or convenient to the **Contractor** for furnishing complete Work as shown on the Plans or specified in these Contract Documents.

C. Related Work Specified Elsewhere:

1. Section 01210 - Measurement and Payment
2. Section 02200 - Earthwork
3. Section 02324 - Trenching and Trench Backfilling
4. Section 02920 - Site Restoration
5. Section 03300 - Cast-In-Place Concrete

1.02 SUBMITTALS

Submittals shall be made in accordance with the requirements of **Section 01300 - Submittals**.

1.03 QUALITY ASSURANCE

A. 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. AASHTO M147 - 65 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in) Drop.

3. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

4. ASTM D698 – 00a - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3; 600 kN-m/m3).

5. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft3; 2,700 kN-m/m3).

6. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

7. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Coarse aggregate shall be crushed stone of a quality equal to the best Stone Mountain Granite, of solid composition, free from dirt and adherent coatings, and suited for the class of its intended usage.

B. Unless otherwise specified elsewhere in these Specifications or directed by the **Owner**, gradation of coarse aggregate shall conform to size Number 57 (maximum stone size of 1 ½ inch) as described in ASTM C33.

C. The nominal maximum size of coarse aggregate used in concrete shall not be larger than one-fifth (1/5) of the narrowest dimension between sides of the forms, one-third (1/3) of the depth of slabs, or three-fourths (3/4) of the minimum clear spacing between reinforcing bars as described in ACI 68-50.

D. Sand shall be clean and sharp, free from all deleterious substances, and shall conform to the requirements of ASTM C33.

PART 3 - EXECUTION

3.01 EXAMINATION

The **Contractor** shall verify that subgrade has been inspected and that gradients and elevations are correct and dry.

3.02 AGGREGATE PLACEMENT

A. The **Contractor** shall place coarse aggregates in areas shown on the Plans or directed by the **Owner**.

B. The **Contractor** shall place and compact coarse aggregate in accordance with the requirements of **Section 02200 - Earthwork** and **Section 02324 - Trenching and Trench Backfilling.**

C. The **Contractor** shall level and contour surfaces to elevations and gradients indicated on the Plans.

D. The **Contractor** shall add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

E. The **Contractor** shall add water to assist compaction. If excess water is apparent, the **Contractor** shall remove aggregate and aerate to reduce moisture content.

F. The **Contractor** shall use mechanical vibrating tamping in areas inaccessible to compaction equipment.

3.03 TOLERANCES

A. Flatness: Maximum variation of one-quarter (¼) inch measured with a ten (10) foot metal straight edge.

B. Scheduled Compacted Thickness: Within one-quarter (¼) inch.

C. Variation from True Elevation: Within one-half (½) inch.

D. Base: Compacted to ninety-five (95) percent modified proctor density as determined by ASTM D1557.

+++ END OF SECTION 02060 +++

SECTION 02110
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 SCOPE

A. 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.

B. The extent of route clearing is that the minimum degree of clearing necessary to carry out all construction activities including construction of appurtenances and other additional clearing needed for access purposes.

C. Clearing and grubbing operations shall be coordinated with temporary and permanent erosion control requirements.

D. 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

E. Related Work Specified Elsewhere:

1. Division 1 General Requirements
2. Section 02125 - Temporary and Permanent Erosion and Sediment Control.
3. Section 02050 - Demolition.
4. Section 02200 - Earthwork.

1.02 JOB CONDITIONS

A. Protection of Existing Improvements:

1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing improvements.

2. 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.

B. Protection of Existing Trees and Vegetation:

1. 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 dripline. Provide temporary fences, barricades or guards as required to protect trees and vegetation to be left standing.

2. 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.

3. 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 **Owner**. 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

3.01 EXISTING TREES AND VEGETATION

A. 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.

3.02 CLEARING AND GRUBBING

A. Clearing operations shall begin no more than seven days before beginning construction work for any area.

B. 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.

C. 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.

D. 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.

E. 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.**

F. 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**.

G. Where the tree limbs interfere with utility wires, or where the trees to be fallen are in close proximity to utility wires, the tree shall be taken down in sections to eliminate the possibility of damage to the utility.

H. Any work pertaining to utility poles shall comply with the requirements of the appropriate utility.

I. 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.

J. 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

K. Burying of residual materials and organics will not be allowed.

L. 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.

M. Remove lawn sod by cutting it to 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**.

N. Remove above-grade structures only where shown on the Drawings or as authorized by the **Engineer.**

3.03 HOLES AND DEPRESSIONS

A. A. 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.

B. B. Place fill material in horizontal layers not exceeding six inches loose-depth and compact to a 95 per cent standard Proctor.

3.04 DISPOSAL OF WASTE MATERIALS

A. 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.

B. The debris resulting from the clearing and grubbing operation shall be hauled to an off-site 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.

C. All materials that are cleared and grubbed from the project site shall be properly disposed of offsite.

D. Burning of debris onsite may be permitted; however, the **Contractor** must obtain a permit from the appropriate agency prior to burning.

3.05CONSTRUCTION ACCESS ROUTE ON EASEMENT

A. 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.

B. 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.

C. The filter fabric for use under the stone shall be as specified in **Section 02125 - Temporary and Permanent Erosion and Sediment Control**.

D. 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.

3.06 TREE REMOVAL ON EASEMENTS

A. The **Contractor** shall confirm ownership of all on-site trees within the easement before work commences.

B. All trees that need further processing (wood chips) on-site or disposal off-site must be processed or disposed of in conformance with the Federal, State, and local rules and regulations.

C. **Contractor** must acquire any additional permits prior to commencement of any type of work done in the easement

D. Stemmed vegetation such as brush, shrubs, and trees as necessary shall be removed at or near the ground level, leaving the root systems intact.

E. Trees shall be felled into the cleared construction area or areas to be cleared and not onto vegetation to be preserved.

F. Trees that have fallen into water bodies, or beyond the construction area, shall be removed immediately.

+++ END OF SECTION 02110 +++

SECTION 02112
ROUTE CLEARING

PART 1 - GENERAL

1.01 SCOPE

A. The extent of route clearing is that minimum degree of clearing necessary to carry out construction activities such as pipe bursting, pipe repairs and other pipeline renewal processes including construction of appurtenances, as well as other additional clearing needed for access purposes. The route clearing shall not exceed the easement, temporary easement or the signed right of entry agreement.

B. The **Contractor** shall endeavor to minimize disruption to the neighborhood and shall adjust route-clearing plans to avoid important landscaping features where practicable.

C. Route clearing operations include, but are not limited to, the following:

1. Protecting existing trees and other vegetation
2. Removing 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. Controlling erosion in disturbed areas

1.02 QUALITY ASSURANCE

A. The **Contractor** shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state, or federal authorities having jurisdiction over the Project. The **Contractor** shall obtain all required permits of a temporary nature for construction operations.

1.03 JOB CONDITIONS

A. Protection of Existing Improvements:

1. Provide barricades, coverings, or other types of protection necessary to prevent unnecessary damage to existing improvements.

2. 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 **Owner** or other parties or authorities having jurisdiction. Replace property line monuments (such as iron pins) removed or disturbed by clearing operations. This work shall be performed by a Land Surveyor licensed in the State of Georgia. A submittal is required with data showing the survey and sealed by the licensed land surveyor.

B. Protection of Existing Trees and Vegetation:

1. Protect existing trees and other vegetation against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip lines, excess foot or vehicular traffic, or 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.

2. Provide protection for tree roots over 1-1/2 inches in 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.

3. Repair or replace unnecessarily damaged trees and vegetation, as determined by the **Owner**, resulting from any construction operation, in a manner acceptable to the property owner and the **Owner** at the **Contractor's** expense. A qualified arborist shall perform tree damage repair. Replace unnecessarily damaged trees that cannot be repaired and restored to full-growth status, as determined by the arborist.

C. Protection of Adjacent Property:

1. Protect improvements, trees and vegetation on adjoining property as well as those on property requiring route-clearing work.

2. Execute work so as not to create a nuisance to any person including persons utilizing adjacent property.

3. Use work methods and provide temporary facilities as necessary to prevent washing, erosion, siltation or dust damage, or hazard to persons and property, within and off the work area.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. The **Contractor** shall furnish equipment of the type normally used in clearing and grubbing operations including, but not limited to, tractors, trucks, loaders, mowers, and clippers.

PART 3 - EXECUTION

3.01 CLEARING

A. Route clearing operations shall begin no more than seven days before beginning construction work for any area.

B. 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. Accurately determine limitations of the construction easement or right-of-way, and keep construction activity within such limits.

C. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all graded areas so that topsoil is free of roots and debris. Topsoil is to be left sufficiently clean so that further picking and raking shall not be required.

D. All stumps, roots, foundations, and planking embedded in the ground shall be removed and disposed of. 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.

E. Landscaping features shall include, but are not necessarily limited to: fences, cultivated trees, and cultivated shrubbery. Property corners, man-made improvements, and 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 **Owner**.

F. Surface rocks and boulders shall be grubbed from the soil and removed from the site if not suitable as riprap.

G. 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.

H. Any work pertaining to utility poles shall comply with the requirements of the appropriate utility.

I. 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, in the **Owner**'s opinion, is significantly damaged shall be replaced with new fence material of equal or better quality and construction. The **Contractor** shall be responsible for the cost of the new fence material if the **Owner** deems the **Contractor** was negligent.

J. Stumps and roots shall be grubbed and removed to a depth not less than two feet below grade. All holes or cavities that 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.

K. The **Contractor** shall exercise special precautions for the protection and preservation of trees, cultivated shrubs, sod, fences, etc. situated within the limits of any temporary easements, but not directly within the permanent easements. The **Contractor** shall be held liable for any damage the **Contractor**'s operations have inflicted on such property.

L. The **Contractor** shall be responsible for all damages to existing improvements outside the permanent easement resulting from **Contractor**'s operations.

M. Remove lawn sod by cutting into the maximum size that can be handled without tearing or stripping sod and the underlying topsoil. Store it for use in restoring the surface area. Water the sod and otherwise maintain it in viable, growing condition. Alternative means of lawn sod replacement may be considered by the **Owner**.

N. Remove above-grade structures only where specifically authorized.

O. Remove conflicting fences and provide effective, temporary measures to prevent domestic animals from wandering to other lands. Reconstruct fences promptly.

P. Remove abandoned underground facilities such as utilities and structures, walls, footings, basements, wells, septic tanks, cisterns, underground pipe, and other items that conflict with construction.

3.02 HOLES AND DEPRESSIONS

A. Fill holes, depressions, and voids created or exposed by clearing operations with non-organic soil material, unless further excavation or earthwork is indicated.

B. Place fill material in horizontal layers not exceeding six (6) inches loose-depth and thoroughly compact to a density at least equal to the adjacent original ground.

3.03 DISPOSAL OF WASTE MATERIALS

A. Disposal General Requirements: Accomplish disposal of 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 of value from the work site before the **Contractor** begins operations, and no assurance exists that any such material shall be on the work site when the **Contractor** begins work.

B. All materials that are cleared and grubbed from the project site shall be properly disposed of offsite.

C. Burning of debris onsite may be permitted; however, the **Contractor** must obtain a permit from the appropriate agency prior to burning.

3.04 DISPOSAL OF DEBRIS

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, **Owner** 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 with an approved permit from the **Owner**. In no case shall any material or debris of any kind be left on the Project, shoved onto abutting private properties, or buried on the Project.

3.05 CONSTRUCTION ACCESS ROUTE ON EASEMENT

A. When directed by the **Owner**, 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.

B. Construction access route shall be cut a minimum of ten (10) feet wide, and six inches (6) 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 (6) inch depth along the roadway.

C. The filter fabric for use under the stone shall be as specified in **Section 02125 - Temporary and Permanent Erosion and Sediment Control**.

D. Surge stone shall be four to six (4” to 6”) inch size riprap type stone, or equivalent. The **Contractor** shall use sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces shall not be acceptable. Specific gravity shall be two (2.0) or greater. Stones shall have less than sixty-six (66) percent wear when tested in accordance with AASHTO T-96.

3.06 TREE REMOVAL ON EASEMENTS

A. The **Contractor** shall confirm ownership of all on-site trees within the easement before work commences and submit a tree removal plan to the **Owner**.

B. The **Owner’s** approval shall be obtained prior to the removal of any trees from the easement such concurrence shall be obtained in writing.

C. The approval of the **Owner** concerning the method and location of disposal of materials shall be obtained before work commences.

D. All trees that need further processing (wood chips) on-site or disposal off-site shall be processed or disposed of in conformance with Federal, State, and local rules and regulations.

E. **Contractor** shall ensure all utilities are located prior to the commencement of any clearing or construction work in the easement.

F. **Contractor** shall acquire any necessary permits prior to commencement of any type of work done in the easement especially for the removal of trees and crossing of waterways.

G. Stemmed vegetation such as brush, shrubs, and trees as necessary shall be removed at or near the ground level, leaving the root systems intact.

H. Trees shall be felled into the cleared construction area or areas to be cleared and not onto vegetation to be preserved.

I. Trees that have fallen into water bodies, or beyond the construction area, shall be removed immediately. All damage and remediation costs shall be the **Contractor’s** expense.

+++ END OF SECTION 02112 +++

SECTION 02125
TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section includes requirements for the provision, maintenance, and subsequent removal of temporary and/or permanent erosion and sediment controls as shown on the approved plans.

B. The temporary erosion and sediment controls specified herein shall be coordinated with the permanent erosion controls, to assure economical, effective, and continuous erosion and sediment control during construction within acceptable limits. Acceptable limits are as established by the Georgia Erosion and Sedimentation Control Act of 1975, as amended, Section 402 of the Federal Clean Water Act, and applicable codes, ordinances, rules, regulations, and laws of local and municipal authorities having jurisdiction.

C. Land disturbance activities shall not commence until the Land Disturbance Permit Stream Buffer variance, and Notice of Intent, if applicable, have been properly issued and all required meetings have taken place.

D. This section requires the **Contractor** to design project specific devices and practices to meet requirements of the related work and references listed below in conjunction with the **Contractor's** own means, methods, and techniques, schedules and sequences of work, and actual conditions encountered. Design shall be performed by professionals experienced and familiar with storm water and drainage characteristics as well as the requirements of references listed below.

E. **Contractor** is advised to thoroughly review the relevant drawings and notes for sampling requirements.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Erosion and Sediment Control Plan

B. Section 02485 - Seeding

C. Section 02486 - Sodding

1.03 REFERENCES

A. Spalding **County's** Soil Erosion and Sedimentation Control Ordinance.

B. Spalding County Stormwater Manual.

C. Manual for Erosion and Sediment Control in Georgia, as published by the Georgia Soil and Water Conservation Commission (current edition).

D. Federal Clean Water Act.

E. Georgia Erosion and Sedimentation Act of 1975, as amended.

F. Georgia Department of Natural Resources, Environmental Protection Division General NPDES Permit # 100002.

1.04 QUALITY ASSURANCE

The **Contractor** shall provide at least one (1) representative involved in the project's land disturbing activities that has successfully completed the erosion and sediment control education and certification program as administered by the Georgia Soil and Water Conservation Commission; this "certified person" shall have completed as a minimum, the Level 1A (Fundamentals) course. A "certified person" shall be present onsite **at all times** when work is being performed. Failure to maintain a certified person onsite at all times shall result in a stop work order or other appropriate enforcement action.

1.05 SUBMITTALS

A. Within fifteen (15) days after the date of the Notice to Proceed, the **Contractor** shall submit a narrative description, stamped/approved LDP drawings and schedule for proposed temporary erosion and sedimentation controls to the **Owner's** for approval. The description and working drawings shall meet the requirements of the Georgia Erosion and Sedimentation Act of 1975 (as amended) and local soil erosion and sedimentation control ordinances. All fines imposed for improper erosion and sedimentation control shall be paid by the **Contractor**.

B. Land disturbance activity shall not commence until the erosion and sedimentation control plans are approved. The **Owner** may provide a reproducible drawing of plan sheets to the **Owner** for **Owner's** use if necessary. The reproducible drawing shall not bear the Design Engineer's seal or logo and is provided only for the **Owner's** convenience in obtaining land disturbance permits.

C. The description and working drawings shall indicate controls that shall minimize erosion and prevent the off-site transport of sediment in storm water and drainage from the jobsite areas.

D. Submit a written plan to the **Owner** for both temporary and permanent grassing. The plan shall include selection of species, dates, and rates of application for seeding, fertilizer, and mulching.

E. Submittals shall be made in accordance with the requirements of the General

Requirements of the Contract Documents and **Section 01300** - **Submittals** of these Specifications. Unless otherwise noted, all submittals shall be produced at the Pre-Construction Meeting. In addition, the following information shall be submitted to the **Owner**:

1. Certification credentials of all persons that have completed the Georgia Soil and Water Conservation Commission's erosion and sediment control education and certification program and that will be involved in the project shall be provided to the **Owner** prior to the start of any land disturbing activities.

PART 2 – PRACTICES AND PRODUCTS

2.01 GENERAL

A. The following paragraphs generally describe the erosion and sediment control practices and products typically employed on a utility construction project. The detailed requirements for these, as well as for other measures which may be needed to achieve effective erosion control, shall be as specified in the Standards and Specifications for General Land Disturbing Activities of the Manual for Erosion and Sediment Control in Georgia.

B. The paragraph titles and alphanumeric codes refer to specific structural and vegetative type practices included in the aforementioned Standards. All practices shall be considered as temporary erosion and sediment control features, except the channel stabilization, gabions and grassing/sodding, trees, shrubs, and groundcovers, which are considered as permanent measures.

2.02 STRUCTURAL PRACTICES

A. CONSTRUCTION EXIT - Co

1. A construction exit consists of a stone-stabilized pad with a geotextile underliner located at any point where traffic shall be leaving a construction site to a public right-of-way, street, alley, sidewalk, or parking area.

2. Construction exits are used to reduce or eliminate transport of mud from the construction area.

3. Construction exits shall consist of graded one and one-half to three and one-half (1.5 to 3.5) inch stone meeting National Stone Association grade R-2. The geotextile underliner shall be a non-woven fabric equal to No. C-45NW as manufactured by Contech Construction Products, Inc. or approved equal.

B. CHANNEL STABILIZATION (RIPRAP) - Ch

1. Channel stabilization consists of structures to stabilize an open channel for water conveyance. Such stabilization is typically applied in those locations

where the channel banks and bed have been disturbed by excavation for a pipeline crossing.

2. Channels shall be stabilized using a rock riprap lining. The lining shall consist of filter bedding stone and graded riprap stone. Sizes of stone shall be as classified by either the National Stone Association (N.S.A.) or the Department of Transportation (D.O.T.). Riprap stone shall be equal to Georgia Department of Transportation Type 1 or Type 3. Filter bedding stone shall be graded stone not exceeding six (6) inches in diameter. An appropriate geotextile fabric may be substituted for filter stone with **Owner** approval.

C. GABIONS – Ga

Gabions are large, multi-celled mesh boxes used in channel revetments, retaining walls, abutments, check dams, etc. Boxes shall be constructed of PVC coated wire mesh and filled with four to eight (4” to 8”) inch pieces of durable stone. Stone placement shall be principally by hand or gentle mechanical dumping in no more than twelve (12) inch layers with PVC coated wire cross and diagonal supports in each cell to retain and support basket sides at those intervals. Minimum size for box gabions shall be 6’-0” x 3’-0” x 3’-0”. Minimum size for Reno Mattresses shall be 9’-9” x 6’-6” x 0’-9”. Gabions shall be manufactured by Maccaferri, USA or approved equal.

D. TEMPORARY STREAM CROSSING - Sr

1. A temporary stream crossing is a structure installed across a flowing stream for use by construction equipment.

2. Structures may include bridges, round pipes, and pipe arches. The structure shall be large enough to convey the full bank flow of the stream and be designed by the **Contractor** to withstand flows from a two (2) year, twenty-four (24) hour frequency storm.

E. CHECK DAMS - Cd

1. Check dams are barriers composed of stone or hay bales placed across a natural or constructed drainage way to prevent erosion in areas of concentrated flows.

2. Stone check dams shall not be utilized where the drainage area exceeds five acres. Hay bale check dams shall not be used where drainage areas exceed two (2) acres. Check dams shall not be installed in live streams.

3. Stone check dams shall be constructed of graded size two to ten (2 to 10) inch stone.

F. SEDIMENT BARRIER

1. STAKED HAYBALES - Sd1

   Hay bale barriers are placed in a single row on natural ground where the most likely erodible areas are located to restrain sediment particles carried by sheet flow.

2. SILT FENCE - Sd1

   a. Silt fences are temporary measures to retain suspended silt particles carried by sheet flow.

   b. Silt fence consists of silt fabric, as specified in the Georgia Department of Transportation list #36, wood or steel posts, and wire or nail fasteners.

   c. Type A silt fence is a non-woven thirty six (36) inch wide filter fabric and shall be used on developments where the life of the project is greater than or equal to six (6) months. The flow rate (gallon/minute/square foot) is twenty-fine (25). Additionally, Type A fabric has a color mark.

   d. Type C silt fence is a woven thirty six (36) inch wide filter fabric with wire reinforcement. The wire reinforcement is necessary because this fabric allows almost three times the flow rate as Type A silt fence. The flow rate (gallon/minute/square foot) is seventy (70). Additionally, Type C fabric does not have a color mark.

G. INLET SEDIMENT TRAP - Sd2

   1. Inlet sediment traps are temporarily protective devices formed around a storm drain inlet to trap sediment.

   2. Inlet sediment traps are used to prevent sediment from leaving a site or from entering storm drain systems prior to permanent stabilization of the disturbed area.

H. ROCK FILTER DAM - Rd

   1. Rock filter dams are installed across small non-actively flowing drainageways and are applicable for projects that involve grading activity directly in those drainageways.

   2. Rock filter dams consist of riprap faced with smaller rock on the upstream side for additional filtering affect.

I. STREAM DIVERSION - PIPED DIVERSION (DV1), PUMPED DIVERSION (DV2), ENGINEERED DIVERSION STRUCTURES (DV3))

1. Installation of water and sewer pipelines designed to cross natural streams shall be accomplished only in “dry channel” conditions (i.e. in the absence of stream flow in the work area). Provisions shall be implemented to divert a constant quantity and quality of stream waters around the construction area by means of adequately sized pipes, pumps, or engineered diversion structures or other methods proposed by the **Contractor** and approved by the **Owner**. These diversion devices shall be maintained throughout the duration of construction within the stream channel. The structures shall be designed by professionals familiar with storm water / drainage characteristics and applicable requirements to withstand flows from a two (2) year, twenty four (24) hour frequency storm event unless otherwise noted on the drawings. Stream diversion devices shall not be removed until all disturbed areas of the stream channel bottom and banks are returned to original contours and stabilized to prevent erosion. The planning, scheduling, and sequencing of work by the **Contractor** shall be described in a detailed submittal to the **Owner** for approval. The final implementation schedule shall only be determined in conjunction with forecasted weather conditions for the period anticipated for diversion.

    a. Piped Diversion - Dv1

        Piped diversions shall be installed and implemented in conjunction with and as an extension of Temporary Stream Crossings - (Sr). Pipes shall be sized as shown on the drawings with sufficient coordination and planning as to their locations, elevations, etc. to allow subsequent water/sewer pipeline construction to occur in “dry channel’ conditions.

        Necessary sandbags or other sealing devices, dewatering, etc. shall be provided to accomplish this piped diversion as well as other “Best Management Practices” to ensure that erosion and sedimentation is controlled.

    b. Pumped Diversion - Dv2

        Pumped diversions shall be installed and implemented in conjunction with and as an extension of Temporary Stream Crossings (Sr). Pumps and piping shall be sized as shown on the drawings with sufficient coordination and planning as to their locations, elevations, etc. to allow subsequent water/sewer pipeline construction to occur in “dry channel” conditions.

        Necessary sandbags or other sealing devices, dewatering, discharge sediment basins, sediment filter socks, “floc logs,” “dirt bags,” etc. shall be provided to accomplish this pumped diversion as well as other “Best Management Practices” to ensure that erosion and sedimentation is controlled.

c. Engineered Diversion Structure - Dv3

Engineered diversion structures such as “Aqua Barrier” by Nilex, Inc., “Portadam” by Portadam Inc, interlocked sheet piling, riprap cofferdams, etc. shall be installed and implemented to allow subsequent water/sewer pipeline construction to occur in “dry channel” conditions. Sequential work elements may be involved to allow the construction area to progress across a stream, and ensuring that the previously completed segment is reasonably restored and stabilized.

Necessary sandbags, geotextiles, linings, or other sealing devices, dewatering, etc, shall be provided to accomplish this manner of diversion as well as other “Best Management Practices” to ensure that erosion and sedimentation is controlled.

2.03 VEGETATIVE PRACTICES

A. GENERAL

1. Disturbed areas shall be stabilized as construction progresses. For sanitary sewers or water mains installed within easements, the construction corridor shall not exceed one thousand (1,000) linear feet without stabilization. All other projects shall not exceed three hundred (300) linear feet without stabilization.

B. DISTURBED AREA STABILIZATION (WITH MULCHING ONLY) - Ds1

1. This practice is applicable where disturbed areas, temporarily idle, have not been established to final grade and/or where permanent vegetative cover is delayed for a period not to exceed six (6) months.

2. Mulch materials shall consist of dry straw or hay, wood chips, erosion control matting or netting, or polyethylene film. The mulch shall be uniform, spread over the designated area from two to four (2 to 4) inches thick.

3. Any and all disturbed areas that have not yet reached final grade shall be stabilized with mulch or temporary grassing within fourteen (14) calendar days of disturbance.

C. DISTURBED AREA STABILIZATION (WITH TEMPORARY SEEDING) - Ds2

1. Temporary seeding is a measure consisting of seeding and mulching to reduce erosion. All disturbed areas shall be seeded when and where necessary to reduce erosion.

2. This practice is applicable where disturbed areas, temporarily idle, have not been established to final grade and/or where permanent vegetative cover is delayed for up to six (6) months.

3. Temporary seeding consists of a grass or grass-legume mixture suitable to the area and season of the year.

D. DISTURBED AREA STABILIZATION (WITH PERMANENT VEGETATION) - Ds3

See Section 02485 – Seeding

See Section 02486 – Sodding

See Section 02490 – Trees, Shrubs, and Ground Cover

1. Permanent (perennial) vegetation shall consist of planted grasses, trees, shrubs, and/or perennial vines; a crop of perennial vegetation appropriate for the time of year and region (or to match, in kind, pre-existing maintained vegetation); or a crop of annual vegetation and seeding of target crop perennials appropriate for the region (or to match, in kind, pre-existing maintained vegetation), such that within the growing season a seventy (70) percent coverage by perennial vegetation shall be achieved.

2. This practice is applicable on disturbed areas at final grade.

3. Permanent perennial vegetation shall be applied on rough graded areas that shall be undisturbed for more than (6) months.

E. DISTURBED AREA STABILIZATION (WITH SODDING) - Ds4

See Section 02485 – Seeding

See Section 02486 – Sodding

1. This practice shall consist of ground preparation, furnishing lime and fertilizer and placement of sod.

2. Sod shall be from local area and delivered to the job site in either industry standard blocks or rolls. Sod shall not be delivered to the job site more than twenty-four (24) hours prior to installation. Sod shall be hand placed with edges butted and cut as required to fit the placement area. The finished installation shall be rolled with a lawn roller and thoroughly watered. The sod shall be watered daily for the first five days after installation.

3. Sod shall be anchored on slopes steeper than three to one (3:1).

F. EROSION CONTROL MATTING AND BLANKETS - Mb

1. This practice is a protective covering (blanket) or soil stabilization mat used to stabilize disturbed areas until permanent vegetation on steep slopes, channels, or shorelines can be established.

2. Concentrated flow areas, all slopes steeper than two and one-half to one (2.5:1) and with a height of ten (10) feet or greater, and cuts and fills within stream buffers, shall be stabilized with the appropriate erosion control matting or blankets.

3. All blanket and matting materials shall be on the Georgia Department of Transportation Qualified Products List (QPL #62 for Blankets, QPL #49 for Matting).

G. JOINT PLANTING STABILIZATION (rip-rap and willow stakes)

Joint planting is a system that installs live willow stakes between riprap (type 3) placed previously along the stream bank. It is installed to increase the effectiveness of the rock system by forming a living root mat in the base upon which rock has been placed and improve the environmental function and aesthetics of the rock bank. The rock shall be principally placed by hand or gentle mechanical dumping. Willow stake density of installation shall be 3 to 5 cuttings per square yard. Cuttings shall be two (2) inches in diameter and three and one–half (3.5) feet in length. The cutting shall be freshly cut and alive. Two thirds (2/3) of live stake shall be in the ground below the previously placed rock. Only native species willow stakes shall be used.

PART 3 - EXECUTION

3.01 GENERAL

A. At the Preconstruction Conference, the **Contractor** shall submit a schedule for accomplishing the temporary erosion control work for specific conditions to be encountered on the project.

B. The **Contractor** shall install all erosion and sediment control devices as required by actual field conditions, as shown on the approved plans, or as directed by the **Owner** or by any agency having jurisdiction in the locale of the project.

C. The erosion and sediment control devices shall be installed by the **Contractor** before land disturbing activities begin.

D. The **Owner** has the authority to direct the **Contractor** to provide immediate, additional temporary erosion control measures to prevent contamination of adjacent waterways and drainage ways. Additional erosion control measures may be used to correct conditions that develop during construction that were not foreseen during the design stage or that are needed prior to installation of the permanent erosion control features.

E. The **Owner** may limit the area of excavation in progress based on the **Contractor's** capability and progress in keeping the finish grading, mulching, and seeding current, in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion

control measures, such as mulching or temporary seeding, shall be taken immediately to the extent feasible and justified.

F. The **Contractor** shall incorporate all permanent erosion control features (grassing and sodding) into the project at the earliest practicable time.

3.02 INSTALLATION

A. Erosion control measures shall be designed by professionals familiar with storm water and drainage characteristics, installed, and maintained in accordance with the "Manual for Erosion and Sediment Control in Georgia" published by the Georgia Soil and Water Conservation Commission.

3.03 INSPECTION

A. Upon completion of installation, the **Owner** shall inspect the erosion and sediment control devices for proper installation, flaws, defects, or other damage. The **Contractor** shall repair or replace, at its expense, the unacceptable portions as directed by the **Owner.**

B. All erosion and sediment control devices shall be inspected by the **Contractor** at least weekly and after each rainfall occurrence.

C. All projects that require compliance with General NPDES Permit 100002 guidelines shall have inspections and monitoring in accordance with the specific Comprehensive Monitoring Plan.

3.04 MAINTENANCE

A. The **Contractor** shall maintain the erosion and sediment control devices until the project is completed and all disturbed areas are stabilized. Maintenance of the devices shall include: removal and disposal of silt accumulation; replacement of damaged or deteriorated devices; other repairs; and the installation of additional devices should those devices installed prove to be inadequate. The **Contractor** shall provide this maintenance at no additional cost to the **Owner**.

Silt shall be cleaned out once it has accumulated to half the height of the device or when half of the available sediment storage capacity has been attained.

3.05 REMOVAL

A. Temporary erosion and sediment devices shall remain in place until such time as a satisfactory stand of grass has been established, unless the **Owner** or local government authority directs earlier removal. Damaged or otherwise unusable devices shall be removed from the site and disposed of properly.

B. After erosion and sediment device removal, the **Contractor** shall dress out any

disturbed areas in the vicinity of the removed device and grass according to these Specifications.

+++ END OF SECTION 02125 +++

SECTION 02140
DEWATERING

PART 1 - GENERAL

1.01 SCOPE

A. Construct all permanent Work in areas free from water. Design, construct, and maintain all dikes, levees, cofferdams, 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.

B. 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**.

C. The **Contractor** shall be responsible for the prevention of significant surface settlement that could cause damage to nearby structures or buildings on adjacent properties to the Work. Dewatering activities that include recharging of groundwater near any existing structures or buildings shall be included in the Groundwater Control Plan. Repairs to existing structures or buildings that are damaged due to dewatering activities during construction is the sole responsibility of the **Contractor** and shall incur no additional cost to the **Owner**.

1.02 RELATED SECTIONS

A. Section 01714 – Pre-Construction & Post-Construction Inspections and Surveys

B. Section 02125 – Temporary and Permanent Erosion and Sediment Control

C. Section 02200 – Earthwork

1.03 SUBMITTALS

NONE

1.04 FIELD CONDITIONS

A. Project-Site Information: Geotechnical reports have been prepared for the project locations at both the Influent Pump Station and the Water Reclamation Facility sites and are available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical

engineer. The **Owner** is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering in accordance with the performance requirements.

2. The geotechnical reports are provided for reference elsewhere in Project Documents.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 – PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.

2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.

3. Prevent surface water from entering excavations by grading, dikes, or other means.

4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.

5. Remove dewatering system when no longer required for construction.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.01 GENERAL

A. The **Contractor** shall continuously control water during the course of construction, including weekends and holidays, and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. For Other Portions of the Project: Remove and control water during periods when necessary to properly accomplish the Work.

3.02 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify the **Owner** if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

C. Prepare reports of observations.

3.03 CARE OF WATER

A. 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 if approved by the **Owner**.

B. 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.

C. 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.

D. 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.

E. When the temporary works will not adversely affect any item of permanent work or the planned usage of the Project, the **Contractor** shall receive approval from the **Owner** to leave such temporary works in place. In such instances, breaching of dikes, levees, and cofferdams may be required.

3.04 DEWATERING

A. 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.

B. Excavations shall be continuously dewatered to maintain a groundwater level no higher than two (2) feet below the lowest point in the excavation.

C. The **Contractor** shall use piezometric observation wells to monitor the groundwater level and to ensure 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.

D. Provide, operate, and maintain recharging systems (which may include reinjection wells and infiltration trenches) of sufficient size and capacity to prevent a drop in groundwater table adjacent to existing structures, underground utilities, and roadways due to dewatering.

E. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.

2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.

3. To relieve artesian pressures and resultant uplift of excavation bottom.

F. Provide sufficient redundancy in each system to keep excavation free of water in the event of component failure.

G. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

H. No separate payment shall be made for dewatering required to accomplish the work.

3.05 MONITORING FLOWS

A. Monitor volume of water pumped per calendar day from excavations, as Work progresses. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to the **Engineer**.

3.06 DISPOSAL OF WATER

A. Obtain discharge permits for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory

agencies, prior to discharge.

C. Discharge water as required by discharge permit and in a manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

3.07 PROPERTY PROTECTION

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent any settlement and/or related damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

C. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the **Owner** and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.08 REMEDIATION OF GROUNDWATER DEPLETION

A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to well owner prior to beginning the Work or as satisfactory to each well owner.

+++ END OF SECTION 02140 +++

SECTION 02200
EARTHWORK

PART 1 – GENERAL

1.01 SCOPE

A. The work under this Section includes earthwork and related operations, including, but not limited to; excavating all classes of material encountered; trenching; handling; storage; transportation; and disposal of all excavated and unsuitable material; construction of fills and embankments; backfilling around structures; backfilling all pits; compacting; all sheeting; shoring and bracing; preparation of subgrades; surfacing and grading; and any other similar, incidental, or appurtenant earthwork operation which may be necessary to properly complete the Work.

B. The **Contractor** shall provide all services, labor, materials, and equipment required for all earthwork and related operations necessary or convenient to the **Contractor** for furnishing complete Work as shown on the Drawings or specified in these Contract Documents.

C. Related Work specified elsewhere:

1. Section 01410 - Testing Laboratory Services
2. Section 02125 - Erosion and Sedimentation Control
3. Section 02140 - Dewatering
4. Section 02324 - Trenching and Trench Backfilling

1.02 GENERAL

A. Safety: Comply with local regulations and with provisions of the “Manual of Accident Prevention in Construction” of the Associated General Contractors of America, Inc. Occupational Safety and Health Act (OSHA) and all other applicable safety regulations.

B. The elevations shown on the Drawings as existing are taken from the best available data and are intended to give reasonable information about the existing elevations. The **Contractor** shall verify conditions to determine the exact quantities of excavation and fill required.

C. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards.

D. All excavated and filled areas for structures, trenches, fills, topsoil areas, embankments and channels shall be maintained by the **Contractor** in good condition at all times until final acceptance by the **Owner**. All damage caused by erosion or other construction operations shall be repaired by the **Contractor** using material of the same type as the damaged material at no cost to the **Owner**.

E. The **Contractor** shall control grading in a manner to prevent water running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm water can flow uninterrupted in existing open ditches or channels; other surface drains; or temporary drains.

F. No classification of excavated materials will be made, except for rock excavation. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the Work, regardless of the type, character, composition or condition thereof.

G. The soil testing will be performed by the **Contractor's** testing laboratory. As a minimum at least one density test shall be performed for every 5,000 square feet of fill area and every two feet of fill lift.

H. **Contractor** shall provide at least 24 hours advance notice of earthwork operations to the Testing Laboratory. Testing Laboratory shall provide reports to the **Engineer** with copies to the **Contractor** certifying (and sealed by a Registered Georgia Engineer) that earthwork is in conformance with the plans and specifications. The Testing laboratory shall witness the placement of all fill, unless otherwise directed by the **Engineer**.

I. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, Excavations, Trenching, and Shoring, and Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations, and shall be conducted in a manner acceptable to the **Engineer**.

J. Stockpile Areas: Provided there is space available, stockpiling material may be on site.

1.03 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:

A. Copies of permits obtained by the **Contractor** for the work.

B. Test results, certification of compliance, source and samples for all imported materials.

C. Samples of fill materials to be used. Samples shall be submitted 2 weeks in advance of use and shall consist of 0.5 cubic feet of each type of material.

D. Test reports for compaction.

1.04 QUALITY ASSURANCE

Reference Standards. Comply with all Federal, State and local laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

A. ASTM C136-84a, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ASTM D1556-82, Test Method for Density of Soils in Place by the Sand Cone Method.

C. ASTM D1557-78, Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in. (457-mm Drop).

D. ASTM D3107-88, Test Method for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

PART 2 – PRODUCTS

2.01 MATERIALS

A. Earthwork Materials

1. Controlled Fill:

a. Proposed fill soils shall be laboratory tested prior to construction use to determine their suitability. All fill material shall be subject to the approval of the **Engineer**.

b. Notification: For approval of imported fill material, notify the **Engineer** and Testing Laboratory at least three (3) weeks in advance of intention to import material, designate the proposed borrow area, and permit the Testing Laboratory to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material. Test results shall be submitted to the **Engineer** for approval. All fill shall be free of organic matter or debris, have low to moderate plasticity, (PI$\leq$15) uniform composition, and be free of rock fragments greater than three inches in dimension. Soils selected for use as fill material shall also have a standard Proctor (ASTM D 698) maximum dry density of at least 90 pounds per cubic foot.

c. All on-site fill material shall be soil exclusive of organic matter, frozen lumps or other deleterious substances.

d. It shall contain no rocks or earth clumps over 2-inches maximum in dimension.

2. Structural Fill and Structural Backfill:

a. Select on site materials may be suitable. Testing and recommendation of suitability shall be made by the Testing Laboratory and submitted by the **Contractor** to the **Engineer** for approval.

b. Imported material shall be sand, uniformly graded crushed rock or other select material recommended by the Testing Laboratory and submitted by the **Contractor** to the **Engineer** for approval.

c. Crushed Rock: Crushed rock used for bedding and drainage stone shall conform to the Georgia Department of Transportation Standard Specifications for construction of Road and Bridges, Section 800 for No. 57 Stone.

3. Coarse Aggregate: Coarse aggregate shall conform to the Georgia Department of Transportation Standard Specifications of Transportation Systems construction of Road and Bridges, Section 800 for No. 57 Stone, Group II, and shall have the following gradation:

Sieve size	**Percent Passing**	
1-½ inch	100	-
1 inch	95	100
¾ inch	-	-
½ inch	25	60
3/8 inch	-	-
#4	0	10
#8	0	5

4. Topsoil: Dark organic weed free loam.

B. Sheeting, Bracing and Timbering: The **Contractor** shall furnish, place and maintain all sheeting, bracing and timbering required to properly support trenches and other excavations in open cut and to prevent all movement of the soil, pavement, structures, or utilities outside of the trench or pit.

1. General:

a. All cofferdams, sheeting, bracing and timbering shall be designed, sealed and signed by a registered Professional Engineer in the State of Georgia at the **Contractor's** expense. A copy of the drawings and design computations shall be submitted to the **Engineer** for the project files.

b. Sheeting, bracing and timbering shall be so placed as to allow the Work to be constructed to the lines and grades shown on the Drawings.

c. If at any time the method being used by the **Contractor** for supporting any material or structure in or adjacent to any excavation is not reasonably safe the **Engineer** may require and the **Contractor** shall provide additional bracing and support necessary to furnish the added degree of safety. The **Contractor** shall provide such added bracing and support by such method as **Contractor** may elect to use, but the taking of such added precautions shall in no way relieve the **Contractor** of sole and final responsibility for the safety of lives, work and structures.

d. All sheeting and shoring in contact with the concrete or masonry shall remain in place. The sheeting or shoring above the structure may remain in place or be cut off. No sheeting shall be left in place within three feet below the ground surface.

e. There shall be no payment for sheeting, bracing, and timbering left in place.

2. Timber:

a. Timber may be substituted for steel sheet piling when approved by the **Engineer**. Timber for shoring, sheeting or bracing shall be sound and free of large or loose knots and in good condition. Size and spacing shall be in accordance with OSHA regulations.

b. Remove bracing and sheeting in units when backfill reaches the point necessary to protect the work and adjacent property. Leave sheeting in place when it cannot be safely removed. Cut off sheeting left in place below the finished ground surface by three feet.

3. Steel Sheet Piling:

Steel sheet piling shall be the continuous interlock type. The weight, depth and section modulus of the sheet piling shall be sufficient to restrain the loads of earth pressure and surcharge from existing foundations. Procedure for installation and bracing shall be so scheduled and coordinated with the removal of the earth that the ground under existing structures shall be protected against lateral or vertical movement at all times. In addition to the drawings and computations, the **Contractor** shall provide closure and sealing details between sheet piling and existing facilities, as well as method of excavation within sheet piling to the **Engineer** for review before commencing with construction operations. **Contractor** shall be responsible for all damage to existing utilities and structures resulting from installation of sheet piling. Damage to existing utilities and/or structures resulting from installation of sheet piling shall be repaired at the **Contractor's** expense.

C. Other Materials: All other materials not specifically described but required for proper completion of the work of this Section, shall be as selected by the **Contractor** subject to the prior approval of the **Engineer**.

D. Stockpile area: The stockpile area shown on the drawings, or as directed by the **Engineer**, shall be used to stockpile soil material for backfilling around structures and to stockpile needed topsoil.

PART 3 – EXECUTION

3.01 GENERAL

A. Benching of Slopes: When the embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when the embankment is to be built ½ width at a time, the slopes that are steeper than 4:1 as measured at right angles to the embankment shall be continuously benched over those areas as the work is brought up in layers. Benching shall be of sufficient width to permit the operation of placing and compacting equipment. Each successive cut shall begin at the intersection of the original ground and the vertical side of the previous cut. Material thus cut shall be recompacted along with the new embankment material. Proof roll subgrade prior to placement of fill material.

B. Topsoil:

1. Remove all topsoil to a depth at which subsoil is encountered, from all areas, which are to be cut to lower grades or filled.

2. Topsoil to be used for finish grading may be stored on the site. It shall be piled properly, sloped to drain and covered.

C. Bracing and Sheeting:

1. Furnish, install, and maintain all sheeting, bracing, and shoring as may be required to properly support the sides of all excavations and to prevent all movement of earth, which could in any way injure the work, adjacent property, or workmen.

2. Properly support all trenches for duct bank installation so as to conform to all pertinent rules and regulations and these Specifications. All trenches deeper than 5 feet shall be shored unless cut to the angle of repose of the excavated soils.

3. Exercise care in the removal of sheeting, shoring, bracing and timbering to prevent collapse or caving of the excavation faces being supported and damage to the work and adjacent property.

4. Do not leave any sheeting or bracing in the trench or excavation after completion of the work, unless approved or instructed by the **Engineer**. The cost of removing sheeting or bracing shall be at the **Contractor's** expense.

5. All sheeting and shoring in contact with concrete or masonry shall remain in place. The sheeting and shoring above the structure may remain or be cut off. No sheeting or shoring left in place shall be within three feet below the ground surface.

D. Obstructions:

1. Remove and dispose of all trees, stumps, roots, boulders, pavement, pipes and the like, as required for the performance of the work.

2. Exercise care in excavating around catch basins, inlets, manholes, piping, duct banks, underground vaults, etc.

3. Avoid removing or loosening castings or pushing dirt into structures.

4. Damaged or displaced castings shall be repaired and replaced, and dirt entering the structures during the performance of the work shall be removed at no additional cost to the **Owner**.

E. Utilities to be Abandoned:

1. When pipes, conduits, sewers or other structures are removed from the trench leaving dead ends in the ground, such ends shall be fully plugged and sealed as indicated on the Drawings.

2. Abandoned structures such as manholes, catch basins or chambers shall be entirely removed unless otherwise specified or indicated on the Drawings.

3. All materials from abandoned utilities which can be readily salvaged shall be removed from the excavation and stored on the site at a location as directed by the **Engineer**.

4. All salvageable materials will remain the property of the **Owner** unless otherwise indicated by the **Engineer**.

F. Extra Earth Excavation:

In case of soft material, which, in the opinion of the **Engineer** is not suitable, is encountered in the bottom of a trench or underneath a structure, the soft material shall be removed and replaced with structural fill or coarse aggregate.

G. Cutting Paved Surfaces and Similar Improvements:

1. Remove existing pavement as necessary for installing utilities and appurtenances or as otherwise shown on the Drawings.

2. Before removing any pavement, mark the pavement neatly, paralleling pipelines and existing street lines. Space the marks to match the width of the trench.

3. Sawcut the asphalt pavement along the marks before breaking away from the part of pavement that should remain.

4. Do not pull pavement with machines until completely broken and separated from pavement to remain.

5. Do not disturb or damage the adjacent pavement. If the adjacent pavement is disturbed or damaged, remove and replace the damaged pavement.

NOTE: No additional payment will be made for removing and replacing damaged adjacent pavement.

6. Remove and replace sidewalks disturbed by construction for their full width and to the nearest undisturbed joint.

7. The **Contractor** may tunnel under curbs that are encountered. Remove and replace any curb disturbed by construction to the nearest undisturbed joint.

H. Dewatering:

1. The proposed dewatering plan shall be submitted by the **Contractor** to the **Engineer** for approval at least ten (10) working days prior to the beginning of any excavation.

2. 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.

3. 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.

4. Excavations shall be continuously dewatered to maintain a ground water level no higher than 3 feet below the lowest point in the excavation.

5. The cost for all dewatering and discharge shall be at the **Contractor's** expense and shall be considered incidental.

3.02 EXCAVATION

A. Method:

1. All excavation shall be by open cut from the surface except as indicated on the Drawings.

2. All excavations for appurtenances and structures shall be made in such manner and to such depth and width as will give ample room for building the structures and for bracing, sheeting, and supporting the sides of the excavation, for pumping and draining groundwater and wastewater which may be encountered, and for the removal from the trench of all materials excavated.

3. Water shall not be allowed to accumulate in excavations. **Contractor** shall provide sufficient temporary pumping to assure that surface and ground waters do not saturate foundation soils.

4. Take special care so that soil below the bottom of the structure to be built is left undisturbed.

B. Grades:

1. Excavate to lines and grades indicated on the Drawings.

2. Where excavation grades are not indicated on the Drawings, excavate as required to accommodate installation.

C. Disposal of Excavated Material:

1. Remove and legally dispose of all excavated material not needed to complete filling, backfilling, and grading.

2. Dispose of excess excavated material at locations secured by the **Contractor** and 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 on any street or alley. No debris shall be deposited on any private property except by written consent of the property owner. In no case shall any material be left on the Project site, or be buried in embankments or trenches on the Project site.

3. Excavated materials shall be placed adjacent to the work to be used for backfilling as required.

4. Excavated materials shall be placed sufficiently back from the edge of the excavation to prevent caving of the trench wall, to permit safe access along the trench and to not cause any drainage problem. Excavated material shall be placed so as to not damage existing landscape or man-made improvements. Surcharging of any bank is not allowed.

D. Rock Excavation:

1. Rock excavation shall mean rock requiring drilling and blasting that occupies an original volume of at least one (1) cubic yard. Rock shall be considered as material which cannot be removed with a crawler tractor equal to a D-8 Caterpillar, equipped with a single-tooth ripper or by an excavator trackhoe equal to a Caterpillar 225 rated with a ¾ cubic yard capacity with a bucket curling pullout capacity of 25,000 pounds.

2. Where rock is encountered within excavation for structures, it shall be excavated to the lines and grades indicated on the Drawings or as otherwise directed by the **Engineer**. The **Contractor** shall be responsible for obtaining any blasting permits required.

3. If excess excavation is made or the material becomes disturbed so as to require removal below final subgrade elevations or beyond the prescribed limits, the resulting space shall be refilled with Class B concrete in accordance with **Section 03300 - Cast-in-Place Concrete**.

3.03 EXCAVATING FOR STRUCTURES

A. Excavation:

1. All excavation is unclassified and shall be included in the **Contractor's** Base Bid.

2. Excavation shall include all substances to be excavated. Excavation for structures shall be to limits not less than 2 feet outside wall lines, to allow for formwork and inspection.

3. Where rock excavation is carried below grade the **Contractor** shall backfill to grade using concrete or structural fill.

4. Where unsuitable material is encountered, excavate material to a depth acceptable to the **Engineer** and fill with compacted structural fill as required.

B. Excavation for Foundations: Footings and slabs on grades shall rest on undisturbed earth, rock or compacted materials to ensure proper bearing.

1. Unsuitable Foundation Material

a. Any material in the opinion of the **Engineer** which is unsuitable for foundation shall be removed and replaced with coarse aggregate or structural fill material as directed by the **Engineer**.

b. No determination of unsuitability will be made until all requirements for dewatering are satisfactorily met.

2. Foundation in Rock: Foundations for a structure shall be on similar materials. Should excavation for a foundation be partially in rock, the **Contractor** shall undercut that portion of the rock 12-inches and bring the excavation to grade with compacted crushed stone.

C. Construction Observations:

All excavations should be examined by the **Engineer** prior to reinforcing steel placement to verify that the design bearing pressure is available. All excavations should be clean, level and free of ponded water, mud and loose, frozen or water-softened soils. If it is necessary for an excavation to remain open overnight, or if rain is imminent, a 3-to 4-inch thick "mud mat" of Class B concrete may be placed in the bottom of the excavation to protect the bearing soils until reinforcing steel and concrete can be placed.

D. Unsuitable Bearing:

If unsuitable bearing for foundations is encountered at the elevations indicated on the Drawings, the **Engineer** shall be notified immediately.

3.04 EXCAVATION BELOW GRADE AND REFILL

If the bottom of any excavation is taken out below the limits shown on the Drawings or specified, it shall be refilled to the bottom grade, at the **Contractor's** expense, except where rock or unsuitable soil is encountered. The refill shall be 6-inch layers of structural fill or other material satisfactory to the **Engineer**. The type of material to be used shall be the **Engineer's** option.

3.05 BACKFILL AND FILL PLACEMENT

A. Compaction of fill shall be accomplished by placing the fill material in horizontal lifts of six-inches (6") maximum loose thickness and mechanically compacting each lift to at least the specified dry density.

B. All fill placement shall be witnessed by an experienced soils technician of the Testing Laboratory and fill density and moisture tests for each lift shall be performed to verify that the specified degree of compaction is being achieved.

C. Prior to placement of any material in embankments, the area within embankment limits shall be stripped of topsoil and all unsuitable materials removed as described under Excavation. Area to receive fill shall then be scarified to a depth of at least 6-inches.

D. The fill shall be brought to the proposed elevation by placing and compacting only approved fill materials upon a subgrade approved by the **Engineer**.

E. Fill materials shall be placed in continuous approximately horizontal layers extending the full width of the embankment cross-section and the full dimension of the excavation where practicable.

F. The fill shall be placed at a moisture content that corresponds to a +/- 3% of the optimum moisture content, as determined by the standard Proctor moisture-density relationship test.

G. Compaction:

1. The fill shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil.

2. The upper twelve-inches (12") of fill beneath the structures and pavement areas shall be compacted to 98% of the standard Proctor maximum dry density.

3. Scarification and recompacting of the upper fill soils immediately prior to the slab-on-grade and/or pavement construction shall be required.

4. Compaction of embankments shall be by sheepsfoot rollers with staggered uniformly spaced knobs and suitable cleaning devices. The projected area of each knob and the number and spacing of the knobs shall be such that the total weight of the roller and ballast when distributed over the area of one (1) row of knobs shall be 250 psi. Placement and compaction of materials shall extend beyond the final contours sufficiently to insure compaction of the material at the resulting final surface. Final contours shall then be achieved by a tracked bulldozer or grader shaping the face of the embankment.

5. The backfill placement in trenches and behind structures shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil. In confined areas requiring portable compaction equipment the fill material shall be placed in horizontal lifts of four-inches (4") maximum loose thickness.

6. If tests indicate that density of backfill fill is less than that specified, the area shall be either be recompacted or undercut, filled, and compacted until specified density is achieved.

H. Final Grading: Upon completion of construction operations, the area shall be graded to finish contour elevations and grades shown on the Drawings. Graded areas shall be made to blend with remaining ground surfaces. All surfaces shall be left smooth and free to drain.

I. Moisture:

1. If fill material is too wet, provide and operate approved means to assist the drying of the fill until suitable for compaction.

2. If fill material is too dry, provide and operate approved means to add moisture to the fill layers.

J. Proofrolling:

1. All areas where pavement or structures are to be built on compacted fill and other areas where indicated on the Drawing, shall be proofrolled to detect soft spots prior to the placement of fill material or construction of foundations.

2. Proofrolling shall consist of the moving a 20-30 ton loaded dump truck or pneumatic tire roller over the subgrade after the subgrade is shaped. Proofrolling shall be witnessed by the **Engineer**.

3. Pneumatic-tired rollers shall have not fewer than four pneumatic tired wheels which shall be of such size and ply that tire pressures can be maintained between 80 and 100 pounds per square inch for 25,000 pound wheel load during rolling operations. Unless otherwise required, rolling shall be done with

tires inflated to 90 psi. The roller wheels shall be located abreast in a rigid steel frame. Each wheel shall be loaded with an individual weight box so that each wheel will bear an equal load when traversing uneven ground. The weight boxes shall be suitable for ballast loading such that the load per wheel shall be 25,000 pounds. The spacing of the wheels shall insure that the distance between the nearest edges of adjacent tires shall be not greater than one-half of the tire width of a single tire at the operating pressure for a 25,000 pound wheel load. The roller shall be operated not faster than 5 feet/second.

4. Subgrade shall be proofrolled with 6 passes. Depressions that develop during the proofrolling operation shall be filled with suitable material and those filled areas shall be proofrolled with 6 passes. If, after having been filled and proofrolled, the subgrade still contains depressions, the soil shall be undercut to the full depth of the soft material or 5 feet whichever is less, backfilled, and rolled to achieve a compacted subgrade.

5. After the proofrolled subgrade has been accepted by the **Engineer**, the surface of the subgrade shall be finish rolled with a smooth steel wheel roller weighing not less than 10 tons. Finished surface of the subgrade shall be within a tolerance of 0.04 feet at every point.

6. Conduits, pipes, culverts and underdrains shall be neither disturbed nor damaged by proofrolling operations. Rollers shall neither pass over, nor approach closer than 5 feet to conduits, pipes, culverts and underdrains unless the tops of those facilities are deeper than 3 feet.

K. During wet or rainy periods, aeration (drying) shall be required to reduce the fill materials to the required moisture condition. During dry periods, water shall be added to achieve the proper moisture content for compaction. Silty soils, which are wet, shall require aeration prior to compaction even during dry periods.

3.06 BACKFILLING AROUND STRUCTURES

A. General:

1. Remove debris from excavations before backfilling.

2. Do not backfill against foundation walls until so instructed by the **Engineer**

3. Wherever possible, backfilling shall be simultaneous on both sides of walls to equalize lateral pressures.

4. Do not backfill on only one (1) side of vertically spanning walls unless walls are adequately shored or permanent construction is in place to furnish lateral support on both top and bottom of wall.

3.07 GRADING

A. General:

1. Perform all rough and finish grading required to attain the elevations indicated on the Drawings.

2. Perform rough grading to an accuracy of plus or minus 0.10 feet.

B. Grading Around Buildings: Control the grading around buildings so the ground is pitched to prevent water from running into the excavated areas of a building or damaging other site features.

C. Treatment After Completion of Grading:

1. After grading is completed, permit no further excavation, filling or grading, except with the approval of the **Engineer**.

2. Use all means necessary to prevent the erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.08 EXCESS WATER CONTROL

A. Unfavorable Weather:

1. Do not place, spread or roll any fill material during unfavorable weather conditions.

2. Do not resume operations until moisture content and fill density are satisfactory to the **Engineer**.

3. Any inundated area that freezes shall be removed and refilled at the **Contractor's** expense.

B. Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collected in depressions.

C. Pumping, Drainage and Dewatering:

1. Provide, maintain and use at all times during construction adequate means and devices to promptly remove and dispose of all water from every source entering the excavations or other parts of the Work.

2. Dewater by means, which will insure dry excavations, preserve final lines and grades, and do not disturb or displace adjacent soil.

3. All pumping and drainage shall be done with no damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic or the work of other contractors, and in accordance with all pertinent laws, ordinances, and regulations.

4. Do not overload or obstruct existing drainage facilities.

3.09 SETTLEMENT

A. The **Contractor** shall be responsible for all settlement of backfill, fills, and embankments, which may occur within one (1) year after final acceptance of the Work by the **Owner**.

B. The **Contractor** shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after receipt of written notice from the **Engineer**.

3.10 CLEANING

Upon completion of the work of this Section, remove all rubbish, trash and debris resulting from construction operations. Remove surplus equipment and tools. Leave the site in a neat and orderly condition acceptable to the **Engineer**, and in conformance with the General Conditions of the Contract Documents.

+++END OF SECTION 02200+++

SECTION 02223
EXCAVATION BELOW NORMAL GRADE AND CRUSHED STONE REFILL

PART 1 GENERAL

1.01 SCOPE

A. If in the opinion of the **Engineer**, the material at or below the normal grade of the bottom of the trench is unsuitable for foundation, it shall be removed to the depth directed by the **Engineer** and replaced with crushed stone. Normal grade of trench bottom is defined as follows:

Pipe Diameter (Inches)	Normal Grade below Pipe (Inches)
8 - 21	8
24 or greater	12

B. Normal grade below manholes, vaults and other structures shall be 12-inches.

C. Pipe bedding material is not included in the Scope of this Section.

PART 2 PRODUCTS

2.01 MATERIALS

A. Crushed Stone shall be as specified in **Section 02060 - Crushed Stone Aggregate**.

B. (Not Used)

PART 3 EXECUTION

3.01 EXCAVATION AND DRAINAGE

A. Whatever the nature of unstable material encountered, or the ground water conditions, drainage in excavations shall be complete and effective.

B. If the **Contractor** excavates below grade through error or for his own convenience, or fails to properly dewater the excavation, or disturbs the sub grade before dewatering is sufficiently complete, he may be directed by the **Engineer** to excavate below grade as set forth in the preceding paragraph, in which case the work excavating below grade and finishing and placing the refill shall be performed at the **Contractor's** own expense.

3.02 REFILL

A. If the material at the level of trench bottom is unsuitable for foundations, the **Engineer** may require compaction of the unsuitable soil. The **Engineer** may also require the removal of the unsuitable material to such depth and width as he may direct and be replaced with crushed stone.

B. (Not Used)

+++ END OF SECTION 02223 +++

SECTION 02230
GUIDED PIPE BORING AND JACKING
(GUIDED AUGER BORING)

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, materials, and equipment required for installation of steel casing pipe using pilot tube guided auger boring equipment necessary to properly complete pipeline construction as described herein and/or shown on the Drawings.

B. Definition: Pilot tube guided auger boring (i.e. guided auger boring, guided auger system) is herein defined as a steerable auger system for the trenchless installation of jacking pipes.

C. Related Work Specified Elsewhere:

1. Section 01210 - Measurement and Payment
2. Section 02200 - Earthwork
3. Section 02140 – Dewatering
4. Section 02535 - Gravity Flow Sanitary Sewers
5. Section 02537 - Ductile Iron Sanitary Sewer Pipe and Fittings

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of **Section 01300 - Submittals**. In addition, the following specific information shall be provided:

B. Method Submittal: The **Contractor** shall provide for the **Engineer's** approval, a detailed plan for the method proposed for the construction of the casing pipe using a guided auger boring system.

The plan shall address the following:

1. Boring Plan: Describe the method of boring, casing pipe installation, carrier pipe installation.

2. 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 groundwater, citing similar installation conditions and results. This plan shall be submitted to the **Engineer** prior to any construction of the casing.

3. Face Protection: The face of the excavation shall be protected from the collapse of the soil into the casing.

4. Casing Design: Design of the bore pit and required bearing to resist jacking forces is 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**, with the approval of the **Engineer**, at no additional cost. Due to restrictive right-of-way and construction easements, boring and jacking casing lengths less than the nominal length may be necessary.

C. 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:

1. Shop drawings for casing pipe showing sizes and connection details

2. Design mixes for concrete and grout

3. Casing spacers

E. Experience Submittals: Guided auger boring 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 Requirements of the Contract Documents. The **Contractor** or **Subcontractor** proposed to do the work shall have a minimum of five (5) continuous years of experience in guided auger boring and installation of steel casing pipe.

1.03 QUALITY ASSURANCE

A. 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.

B. Supply all equipment and 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), National Electrical Code (NEC), and other recognized standards. Latest revisions of all standards are applicable.

1.04 STORAGE AND PROTECTION

All equipment and materials shall be stored and protected in accordance with the Manufacturer's recommendations..

PART 2 - PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. Casing:

1. 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 A252, Grade 2.

2. As directed by the **Owner,** the outside of the casing pipe shall be coated with coal tar epoxy having a minimum dry film thickness of sixteen (16) mils. Surface preparation shall be SSPC-SP-10. Epoxy shall have a minimum solids content of sixty-five (65) percent by volume and shall be air or airless spray applied, minimum drying time shall be seven (7) 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, Valspar, or approved equal and submitted for approval by the **Owner**.

3. Minimum casing thicknesses shall be 0.25 inches unless otherwise stipulated 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 and all calculations shall be submitted for approval by the **Owner**. Any buckling of the casing due to jacking forces shall be repaired at no additional cost to the **Owner**.

4. Minimum diameters of casing are shown on the Drawings. Larger casings, with the **Owner 's** approval, may be provided at no additional cost to the **Owner**, for whatever reasons the **Contractor** may decide, whether due to casing size availability, line and grade tolerances, soil conditions, etc.

B. Casing Spacers: Casing spacers shall meet one of the following requirements:

1. Casing spacers shall be flanged, bolt-on style with a two-section Type 304 stainless steel shell lined with a PVC liner, minimum 0.09-inch-thick with a

hardness of eighty-five to ninety (85 - 90) durometer and a minimum 58,000-volt dielectric strength in accordance with ASTM D149. Runners shall be attached to stainless steel risers that 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 approved equal.

2. 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.

D. Carrier Pipe: Carrier pipes shall be as specified **in Section 02537 - Ductile Iron Sanitary Sewer Pipe and Fittings**. All joints of pipe in casing shall be restrained.

E. 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. The **Contractor** may submit alternate methods to the **Owner** for approval.

2.02 EQUIPMENT

A. Guided Auger Boring Equipment

1. Type: The system shall be a steerable trenchless installation system suitable for the installation of steel casings typically used for road, highway, railroad and utility crossings. The system shall be a multistage system, which allows for the direct jacking of steel casing pipe.

2. Comparable Equipment Manufacturers: The auger boring system used for this work shall be comparable to equipment manufactured by Herrenknecht/Bohrtec and Akkerman. If requested by the **Owner**, submit evidence that the manufacturer has consistently produced twenty-five (25) products of satisfactory quality and comparable performance over a period of at least five (5) years.

3. Accuracy: The boring machine shall provide an accurate and grade precision in soft displaceable soils and hard non-displaceable soil conditions up to approximately 2,900 PSI or 20 MPA. Acceptance criteria for the installed casing pipe shall be plus or minus one (+/- 1) inch from design grade at any location over the length of casing pipe indicated on the drawings.

4. System Type: The guided auger system shall consist of a hollow pilot tube rod system with a directional head with a slanted face, temporary steel casings with steel augers, pilot tube machine with jacking cylinders and a

hydraulic power pack. The pilot tube guidance system shall consist of a digital theodolite electronic camera, L.E.D. illuminated target and control monitor for the real time constant monitoring and correction for line and grade.

5. Jacking Frame: The jacking frame shall possess adequate strength to advance the pilot tube, the enlargement casing, and the string of product pipe from the drive shaft to the receiving shaft. The jacking force shall be easily regulated down to the safe working load rating of the pipe. The frame shall develop a uniform distribution of jacking forces on the end of the pipe. The auger motor shall possess adequate torque to steer the pilot tube and adequate torque and speed to effectively auger the excavated material from the face of the bore to the drive shaft.

6. Cutter Head: A steering cutting head shall be attached to a continuous auger mounted ahead of the casing pipe. The head shall be controlled manually from the bore pit.

7. Guidance System: The guidance system shall include a electronic hydrostatic water level system and control monitor for real time constant monitoring and correction for grade. Other means for grade indication shall be submitted for acceptance by the **Owner**.

8. Monitoring System: Monitoring equipment shall be provided capable of continuously monitoring, 1) the jacking pressure and advancement of the boring head, 2) deviation off centerline and grade, and 3) indication of the steering head.

9. Soil Removal: A soil removal system shall be provided to safely remove the excavated material from the drive shaft to the surface.

10. The system shall be designed to such that small stones, cobbles and other obstructions can be passed through the boring units having 16-inch or smaller O.D. auger systems if they are 3 to 4-inches in diameter or smaller.

11. Power machinery and tools shall be operated by electricity, compressed air, diesel or other approved power. Electrical tools and equipment shall be grounded in accordance with the latest equipment standards established by the National Electrical Code.

PART 3 - EXECUTION

3.01 GENERAL

A. 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. The **Contractor** shall examine the geotechnical report and borings and obtain all additional information as required to assure that the system provided shall be capable of operating successfully given groundwater conditions, soil type, rock profile, potential for obstructions and all geotechnical parameters pertinent to this type of work. With approval from the **Engineer**, the **Contractor** may perform additional soil investigation at no cost to the **Owner**.

B. When water is encountered, provide and maintain a dewatering system of sufficient capacity to remove water on a twenty-four (24) hour basis keeping excavations free of water until the backfill operation is in progress. Dewatering shall be carried out in such a manner that removal of soil particles is held to a minimum. Dewatering shall comply with the approved Temporary and Permanent Erosion and Sediment Control Plan.

C. 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.

D. Casing 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 shall 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 all damaged property to its original or better condition and is responsible for all associated damages at no cost to the **Owner**.

3.02 SAFETY

A. 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.

B. Perform all activities in accordance with the Occupational Safety and Health Act of 1970, OSHA, 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."

3.03 SURFACE SETTLEMENT MONITORING

A. Provide surface settlement markers, placed as specified and as directed by the **Engineer**. The **Contractor** shall place settlement markers outside the pavement area, along the centerline of the casing or tunnel at twenty (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 ten and twenty-five (10 and 25) feet offset in each direction from the centerline of the casing. Tie settlement markers to benchmarks and indices sufficiently removed as not to be affected by the **Contractor's** operations.

B. Make observations of surface settlement markers, placed as required herein, at intervals acceptable to the **Owner**. In the event settlement or heave on any marker exceeds one (1) inch, the **Contractor** shall immediately cease work and, using a method submitted to and approved by the **Owner**, take immediate action to restore surface elevations to those existing prior to start of the **Contractor's** operations.

C. Take readings and permanently record surface elevations prior to the 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 fifty (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 one hundredth (0.01) of a foot.

D. The **Contractor** shall cooperate fully with jurisdictional personnel. Any settlement shall be corrected by and at the expense of the **Contractor**.

E. Promptly report any settlement and horizontal movement immediately to the **Engineer** and take immediate remedial action at no cost to the **Owner**.

3.04 GUIDED AUGER BORING

A. Acceptable Methods

Three Phase System

Phase 1: Pilot tube installed through the ground from the drive shaft to the receiving shaft by earth displacement with the jacking frame.

Phase 2: An enlargement casing, fitted with a reamer head shall be rigidly connected to the final pilot tube and advanced into the earth behind the pilot tube. An auger shall be used inside the enlargement casing to remove the material being excavated. The auger shall be contained inside the limits of the

enlargement casing as it progresses along the proposed alignment. A train of temporary steel casings with an outside diameter very similar to the enlargement casing and used to move the enlargement casing from the drive shaft to the receiving shaft shall be used. The enlargement casing shall cut a borehole from the drive shaft to the receiving shaft and the temporary casings shall case the hole as it is cut. Each temporary casing shall be fitted with an internal auger to transport the excavated material to the drive shaft where it shall be removed from the shaft and disposed of at an approved location. The pilot tubes shall be recovered in the receiving shaft as the temporary casings are installed.

Phase 3: The carrier pipe shall then be installed directly behind the temporary casing pipe, section-by-section, with the jacking frame. The casing pipes and augers shall be recovered in the receiving shaft as the carrier pipe is installed.

B. Shaft

1. Conduct boring and jacking operations from a shaft excavated at one (1) end of the section to be bored. Where conditions and accessibility are suitable, place the shaft on the lower elevation end of the bore.

2. 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 to maintain the integrity of the shaft and foundation.

3. 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 to create the support necessary to perform the required boring and jacking operation at no extra cost to the **Owner**.

B. Jacking Rails and Frame

1. 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.

2. 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 **Contractor** shall submit calculations detailing the wall pressures exerted by the jacking operations for the full length of the jack distance.

3. 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.

C. Boring and jacking of casing pipes shall be accomplished by the dry auger boring method without jetting, sluicing, or wet boring.

D. Auger the hole and jack the casing through the soil simultaneously.

E. Bored installations shall have a bored-hole diameter essentially the same as the outside diameter of the casing pipe to be installed.

F. 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.

G. Alignment and grade shall be continuously monitored. Make corrections prior to continuing operation.

H. Any casing pipe damaged in jacking operations shall be repaired, if approved by the **Owner**, or removed and replaced at the **Contractor's** own expense.

I. 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.

J. The **Contractor** shall submit for approval to the **Owner** a contingency plan that shall allow the use of a casing lubricant, such as bentonite, in the event excessive frictional forces jeopardize the successful completion of the casing installation.

K. Once the jacking procedure has begun, it shall be continued without stopping until completed, subject to weather and conditions beyond the control of the **Contractor**.

L. Care shall be taken to ensure that casing pipe installed by boring and jacking method shall be at the proper alignment and grade.

M. The **Contractor** shall maintain and operate pumps and other necessary drainage system equipment to keep work dewatered at all times.

N. 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 **Owner**.

O. 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.

3.05 INSTALLATION OF PIPE

A. After construction of the casing or tunnel is complete, and has been accepted by the **Owner**, install the pipeline in accordance with the Drawings and Specifications.

B. Check the alignment and grade of the casing and submit a plan to the **Owner** for approval to set the pipe at proper alignment, grade, and elevation, without any sags or high spots.

C. 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 shall be held in place with a steel strap per the details.

D. With **Owner** approval and as directed by the **Engineer**, close the ends of the casing or tunnel with four (4) inch brick walls, plastered with Portland cement mortar and waterproofed with asphaltic roofing cement.

3.09 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 so as not to endanger or damage either new or existing structures or private or public properties, and to avoid cave-ins, subsidence, or sliding in the banks.

+++ END OF SECTION 02230 +++

SECTION 02231
TREE PROTECTION AND TRIMMING

PART 1 - GENERAL

1.01 SCOPE

A. This section includes the protection and trimming of trees that interfere with, or are affected by, execution of the Work, whether temporary or new construction.

B. Related Work specified elsewhere:

1. Section 02200 – Earthwork

2. Section 02324 - Trenching and Trench Backfilling

3. Section 02920 - Site Restoration

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Requirements of the Contract Documents and **Section 01300 - Submittals**. In addition, the following specific information shall be provided:

1. Product Data: For each type of product indicated.

2. Qualification Data: For firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. The **Contractor** shall include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.

3. Certification: From a qualified forester that trees indicated to remain have been protected during construction according to recognized standards and that the trees were promptly and properly treated and repaired when damaged.

4. Maintenance Recommendations: From a certified arborist for care and protection of trees affected by construction during and after completing the Work.

1.03 QUALITY ASSURANCE

A. 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. Hortus Third: Concise Dictionary of Plants Cultivated in the U.S. and County, 1976.

2. Standardized Plant Names (American Joint Committee on Horticulture Nomenclature).

3. National Arborist Association “Pruning Standards for Shade Trees”, latest revision.

4. ANSI A 300 – Trees, Shrubs, and Other Woody Plant Maintenance – Standard Practices.

5. ASTM D 448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction

6. ASTM D 5268 – Standard Specification for Topsoil Used for Landscaping Purposes.

B. Forester Qualifications: A forester licensed in the State of Georgia.

C. Tree Pruning Standards: The **Contractor** shall comply with the requirements of ANSI A300 unless more stringent requirements are indicated.

D. Pre-installation Conference: The **Contractor** shall conduct a pre-installation conference at the site of the Work.

Before starting tree protection and trimming, the **Contractor** shall meet with representatives of authorities having jurisdiction, including, the **Owner**, consultants, and other concerned entities. The **Contractor** shall review tree protection and trimming procedures and responsibilities. The **Contractor** shall notify participants at least three (3) working days before convening the conference. The **Contractor** shall record discussions and agreements and furnish a copy to each participant.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D448, Size 24, with ninety (90) to one hundred (100) percent passing a two and one half (2½) inch sieve and not more than ten (10) percent passing a three quarter (¾) inch sieve.

B. Topsoil: Fertile, friable, surface soil, containing natural loam and complying with the requirements of ASTM D5268. The **Contractor** shall provide topsoil that is free of stones larger than one (1) inch in any dimension and free of other extraneous or toxic matter harmful to plant growth. The **Contractor** shall obtain topsoil only from well-drained sites where soil occurs in depth of four (4) inches or more; the **Contractor** shall not obtain topsoil from bogs or marshes.

C. Filter Fabric: Manufacturer's standard, non-woven, pervious, geotextile fabric of polypropylene, nylon, or polyester fibers.

D. Webbed Fabric Fence (temporary fencing): Orange polyethylene webbed fabric, forty-six (46) inches high supported by six (6) feet steel channel posts, five (5) feet on center. The **Contractor** shall set posts two (2) feet below grade.

E. Chain Link Fence: Shall meet the requirements of the approved plans and submittals.

PART 3 - EXECUTION

3.01 IDENTIFICATION

A. Prior to any construction, the **Contractor** shall flag all trees on the site of the Work scheduled to be protected. All flagging shall be approved by the **Engineer** prior to startup of the Work and construction activities. The **Engineer** shall be notified immediately of any conflicts with proposed Work, structures, or utilities.

3.02 PREPARATION

A. Temporary Fencing: The **Contractor** shall install temporary fencing as indicated on the Plans or outside the drip line of trees to protect remaining vegetation from construction damage.

The **Contractor** shall install chain link fence according to the requirements of the approved plans and submittals.

B. The **Contractor** shall protect tree root systems from damage due to noxious materials caused by runoff or spillage while mixing, placing, or storing construction materials. The **Contractor** shall protect root systems from flooding, eroding, or excessive wetting caused by dewatering operations.

C. The **Contractor** shall not store construction materials, debris, or excavated material within the drip line of remaining trees. The **Contractor** shall not permit vehicles or foot traffic within the drip line. The **Contractor** shall prevent soil compaction over root systems.

D. The **Contractor** shall not allow fires under or adjacent to remaining trees or other plants.

3.03 EXCAVATION

A. The **Contractor** shall install shoring or other protective support systems to minimize sloping or benching of excavations that could endanger trees.

B. The **Contractor** shall not excavate within drip line of trees, unless otherwise indicated or approved by the **Engineer.**

C. Where excavation for new construction is required within drip line of trees, the **Contractor** shall hand-clear and excavate to minimize damage to root systems. The **Contractor** shall use narrow-tine spading forks and comb soil to expose roots.

1. The **Contractor** shall relocate roots in backfill areas where possible. If encountering large, main lateral roots, the **Contractor** shall expose roots beyond excavation limits as required to bend and relocate them without breaking. If encountered immediately adjacent to the location of new construction and relocation is not practical, the **Contractor** shall cut roots approximately three (3) inches back from new construction.

2. The **Contractor** shall not allow exposed roots to dry out before placing permanent backfill. The **Contractor** shall provide temporary earth cover or pack with peat moss and wrap with burlap. The Contactor shall water and maintain earth in a moist condition. The **Contractor** shall temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

D. Where utility trenches are required within drip line of trees, the **Contractor** shall tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.

Root Pruning: The **Contractor** shall not cut main lateral roots or taproots. The **Contractor** shall cut only smaller roots that interfere with installation of utilities. The **Contractor** shall cut roots with sharp pruning instruments. The **Contractor** shall not break or chop roots.

3.04 REGRADING

A. Grade Lowering: Where new finish grade is indicated below existing grade around trees, the **Contractor** shall slope grade away from trees as recommended by the forester, unless otherwise directed by the **Engineer.**

B. Root Pruning: The **Contractor** shall prune tree roots exposed during grade lowering. The **Contractor** shall not cut main lateral roots or taproots. The **Contractor** shall cut only smaller roots. The **Contractor** shall cut roots with

sharp pruning instruments. The **Contractor** shall not break or chop roots.

C. Minor Fill: Where existing grade is six (6) inches or less below elevation of finish grade, the **Contractor** shall fill with topsoil. The **Contractor** shall place topsoil in a single un-compacted layer and hand grade to required finish elevations.

D. Moderate Fill: Where existing grade is more than six (6) inches, but less than twelve (12) inches below elevation of finish grade, the **Contractor** shall place drainage fill, filter fabric, and topsoil on existing grade as follows:

1. Carefully place drainage fill against tree trunk approximately two (2) inches above elevation of finish grade and extend not less than eighteen (18) inches from the tree trunk on all sides. For balance of area within drip line perimeter, the **Contractor** shall place drainage fill up to six (6) inches below elevation of grade.

2. The **Contractor** shall place filter fabric with edges overlapping six (6) inches minimum.

3. The **Contractor** shall place fill layer of topsoil to finish grade. The **Contractor** shall not compact drainage fill or topsoil. The **Contractor** shall hand-grade to required finish elevations.

3.05 TREE PRUNING

A. The **Contractor** shall prune remaining trees affected by temporary and new construction.

B. The **Contractor** shall prune remaining trees to compensate for root loss caused by damaging or cutting root system. The **Contractor** shall provide subsequent maintenance during Contract period as recommended by the forester.

C. Pruning Standards: The **Contractor** shall prune trees according to the most current revision of ANSI A300 following the following types of pruning:

1. Crown cleaning

2. Crown thinning

3. Crown raising

4. Crown reduction

5. Vista pruning

6. Crown restoration

D. The **Contractor** shall cut branches with sharp pruning instruments. The **Contractor** shall not break or chop branches.

E. The **Contractor** shall chip branches removed from trees. The **Contractor** shall spread chips where indicated or as directed by the **Owner**.

3.06 TREE REPAIR AND REPLACEMENT

A. The **Contractor** shall promptly repair trees damaged by construction operations within twenty-four (24) hours. The **Contractor** shall treat damaged trunks, limbs, and roots according to written instructions of the certified arborist.

B. The **Contractor** shall remove and replace dead and damaged trees that the certified arborist determines to be incapable of restoring to a normal growth pattern.

C. The **Contractor** shall aerate surface soil compacted during construction ten (10) feet beyond drip line and no closer than thirty-six (36) inches to tree trunk. The **Contractor** shall drill two (2) inch diameter holes a minimum of twelve (12) inches deep at twenty four (24) inches on center. The **Contractor** shall backfill holes with an equal mix of augered soil and sand.

3.07 DISPOSAL OF WASTE MATERIALS

A. Burning at the site of the Work is not permitted.

B. Disposal: The **Contractor** shall remove excess excavated material, displaced trees, and excess chips from the site and dispose of them at an approved location.

3.08 MAINTENANCE

A. All protected trees that have been root pruned shall be watered deeply twice a week during periods of hot, dry, windy weather (defined as when daily temperatures rise over eighty-five (85) degrees with no rain in the last 72 hours).

3.09 REPLACEMENT

A. The **Contractor** shall be responsible for replacement of all protected trees that are damaged or destroyed during the construction period. Replacement shall be in equal caliper inches (D.B.H.) to those trees damaged or destroyed and shall be in like species unless otherwise determined by the **Owner**.

3.10 ADJUSTING AND CLEANING

A. At the end of the construction period, the **Contractor** shall remove all protection fencing, trash, and debris within the protection area and finish grade and cover in accordance with the requirements of these Specifications.

+++ END OF SECTION 02231 +++

SECTION 02324
TRENCHING AND TRENCH BACKFILLING

PART 1 - GENERAL

1.01 SCOPE

A. The Work covered under this section consists of furnishing all labor, equipment, and materials and performing all operations in connection with the trench excavation and backfill required to install the pipelines shown on the Plans and as specified in these Specifications.

B. Excavation shall include the removal of all trees, stumps, brush, debris, or other obstacles that remain after the site preparation operations and that may obstruct the Work. Excavation shall also include the excavation and removal of all earth, rock, or other materials to the extent necessary to install the pipe and appurtenances in conformance with the lines and grades shown on the Plans and as specified in these Specifications.

C. Backfill shall include the refilling and compaction of the fill in the trenches and excavations up to the surrounding ground surface or road grade at crossing.

D. Trenches are divided into five areas:

1. Foundation: The area beneath the bedding, sometimes also referred to as trench stabilization.

2. Bedding: The area above the trench bottom (or foundation) and below the bottom of the barrel of the pipe.

3. Haunch: The area above the bottom of the barrel of the pipe up to a specified height above the bottom of the barrel of the pipe.

4. Initial Backfill: The area above the haunching material and below a plane 12 inches above the top of the barrel of the pipe.

5. Final Backfill: The area above a plane 12 inches above the top of the barrel of the pipe.

E. The choice of method, means, techniques, and equipment rests with the **Contractor**. The **Contractor** shall select the method and equipment for trench excavation and backfill depending upon the type of material to be excavated and backfilled, the depth of excavation, the amount of space available for operation of equipment, storage of excavated material, proximity of man-made improvements to be protected, available easement or right-of-way, and prevailing practice in the area.

F. When hazardous or contaminated materials are encountered while performing trench excavation, the **Contractor** shall stop work and report the hazardous or contaminated materials to the **Owner** immediately. The **Owner** will instruct the **Contractor** on the required procedures.

G. Related Work Specified Elsewhere:

1. Section 02200 - Earthwork

2. Section 02140 - Dewatering

3. Section 02535 - Gravity Flow Sanitary Sewers

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Requirements of the Contract Documents and **Section 01300 - Submittals**. In addition, the following specific information shall be provided:

1. The **Contractor** shall submit a work plan for trenching and trench backfilling with complete written description that identifies details of the proposed method of construction and the sequence of operations for construction relative to trenching and trench backfilling. The descriptions, with supporting illustrations, shall be sufficiently detailed to demonstrate to the **Owner** that the procedures meet the requirements of the Plans and these Specifications.

2. The **Contractor** shall submit a dewatering plan in accordance with the requirements of **Section 02140 - Dewatering**.

3. The **Contractor** shall submit backfill material sources and product quality information.

4. The **Contractor** shall submit record documents in accordance with the requirements of the General Conditions. The **Contractor** shall record locations of sewers, as installed, referenced to survey benchmarks. The **Contractor** shall include locations of utilities encountered or rerouted. The **Contractor** shall give horizontal dimensions, elevations, inverts, and gradients. The **Contractor** shall use either GPS technology or a conventional survey to locate utilities.

5. The laboratory shall submit the following reports directly to the **Owner** from the testing services, with a copy to the **Contractor**.

a. Test reports on borrow material

b. Verification of each footing subgrade

c. Field density test reports

d. One (1) optimum moisture-maximum density curve for each type of soil encountered

e. Report of actual unconfined compressive strength and/or results of bearing tests of each of the strata tested

1.03 QUALITY ASSURANCE

A. 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. ASTM C33 - Concrete Aggregates

2. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 or 600 kN-m/m^3)

4. ASTM D2922 - Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)

5. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method

6. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 or 2,700 kN-m/m^3)

7. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

B. Density: All references to "maximum dry density" shall mean the maximum dry density defined by ASTM D1557, except that for cohesionless, free-draining soils, "maximum dry density" shall mean the maximum index density as determined by ASTM D4253. Determination of the density of foundation, bedding, haunching, or backfill materials in place shall meet the requirements of ASTM D1556 and ASTM D2922.

C. Sources and Evaluation Testing: Testing of materials to certify conformance with these Specifications shall be performed by an independent testing laboratory approved by the **Owner**.

1.04 SAFETY

The **Contractor** shall perform all trench excavation and backfilling activities in accordance with the Occupational Safety and Health Act of 1970 (PL 91-596), as amended. The **Contractor** shall pay particular attention to the Safety and Health Regulations Part 1926, Subpart P "Excavation, Trenching & Shoring" as described in OSHA publication 2226.

1.05 TESTING

A. Tests and analysis of fill and borrow material shall be performed in accordance with the requirements of ASTM D1557.

B. Testing shall be performed by an approved independent commercial testing laboratory. The **Contractor** shall coordinate testing.

C. Compaction testing shall be performed in accordance with the requirements of ASTM D1556 or ASTM D2292.

D. If tests indicate Work does not meet specified requirements, the **Contractor** shall remove Work, replace, and retest at no cost to the **Owner**.

1.06 JOB CONDITIONS

A. All operations shall be performed by the **Contractor** in strict conformance with OSHA and any applicable local safety requirements. The **Contractor** shall pay particular attention to safety regulations for excavations and entering confined spaces.

B. Test borings and other exploratory operations may be made by the **Contractor** with **Engineer** approval at no cost to the **Owner**.

C. The **Contractor** shall verify that survey benchmarks and intended elevations for the Work are as indicated on the Plans.

D. It is intended that the Plans show the locations of all known existing surface and subsurface structures. However, the locations of many gas mains, water mains, conduits, sewers, is unknown and the **Owner** assumes no responsibility for failure to show any or all of these structures on the Plans or to show them in their exact locations. It is mutually agreed that such failure shall not be considered sufficient basis for claims for Extra Work or for increasing the pay quantities, unless an obstruction encountered is such as to necessitate substantial changes in the lines or grades or requires the building of special structures, provisions for which are not made in the Plans. Any substantial change shall be determined and approved by the **Engineer**.

E. The **Contractor** shall locate existing underground utilities in the site of the Work. If utilities are to remain in service and in place, the **Contractor** shall provide adequate means of support and protection during trenching and trench backfilling.

F. Utilities Notification Prior to Construction:

1. Georgia law mandates that, before beginning all mechanical digging or excavation work, the **Contractor** shall contact Georgia 811 by using eRequest on www.Georgia811.com or by calling 811 or 1-800-282-7411.

2. The **Contractor** may utilize EDEN (Excavation Digging Event Notification) web application that enables Members and Professional Excavators to create, manage, respond to, and edit Georgia 811 Locate Request Tickets.

3. The **Contractor** shall retain all records of notification and responses during the course of the project until final Payment.

G. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, the **Contractor** shall consult the utility owner immediately for directions. The **Contractor** shall cooperate with utility companies in keeping respective services and facilities in operation. The **Contractor** shall repair damaged utilities to the satisfaction of the utility owner and shall be responsible for all costs associated with the repair or replacement of the damaged utility facilities.

H. Unless specified otherwise in other Specifications Sections, the **Contractor** shall not interrupt existing utilities serving any facilities, during occupied hours, except when permitted in writing by the **Owner** and then only after acceptable temporary, utility services have been provided.

I. The **Contractor** shall provide a minimum of forty eight (48) hour notice to the **Owner** and utility owner, and shall receive written notice to proceed before interrupting any utility.

J. The **Contractor** shall demolish and completely remove from the site of the Work existing underground utilities indicated on the Plans to be removed. The **Contractor** shall coordinate with utility companies for shut-off of services if lines are active. No separate payment shall be made by the **Owner**.

K. The **Contractor** shall protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavations. The **Contractor** shall use augured piles and lagging. Augured piles shall be used instead of vibratory driven piles when near structures or existing sewers.

L. The **Contractor** shall notify the **Engineer** of unexpected subsurface conditions and discontinue work in affected area until the **Contractor** receives notification to resume work.

M. The **Contractor** shall protect the bottom of the trench and soil adjacent to and beneath trench from frost.

N. The **Contractor** shall prevent surface water run-off into a trench.

PART 2 - PRODUCTS

2.01 TRENCH FOUNDATION MATERIALS

Crushed stone shall be utilized for trench foundation (trench stabilization) and shall meet the requirements of the Georgia Department of Transportation Specifications Construction of Transportation Systems 800.2.01, Group I (limestone, marble, or dolomite) or Group II (quartzite, granite, or gneiss). Stone size shall be between No. 57 and No. 4, inclusive.

2.02 BEDDING AND HAUNCHING MATERIALS

A. Unless specified otherwise, bedding and haunching materials shall be crushed stone as specified below.

B. Crushed stone utilized for bedding and haunching shall meet the requirements of **Section 02060 - Crushed Stone Aggregate** and of the Georgia Department of Transportation Specifications Construction of Transportation Systems 800.2.01, Group I (limestone, marble, or dolomite) or Group II (quartzite, granite, or gneiss). Stone size shall be No. 57 or finer based on type and location of pipe to be installed.

C. Filter Fabric - Non-Woven Type:

1. Filter fabric associated with bedding shall be a UV stabilized, spun-bonded, continuous filament, needle-punched, polypropylene, nonwoven geotextile.

2. The fabric shall have an equivalent open size (EOS or AOS) of 120 to 70. The fabric shall also conform to the minimum property values listed in the following table:

Fabric Property	Unit	Test Procedure	Average Value	
			Typical	Minimum
Weight	oz/yd^2	ASTM D 3776	8.3	

Fabric Property	Unit	Test Procedure	Average Value	
			Typical	Minimum
Thickness	mils	ASTM D 1777	105	
Grab Strength	lbs	ASTM D 4632	240	210
Grab Elongation	%	ASTM D 4632	>50	50
Tear Strength	lbs	ASTM D 4533	100	85
Mullen Burst	psi	ASTM D 3786	350	320
Puncture Resistance	lbs	ASTM D 4833	115	100
Permittivity	sec^{-1}	ASTM D 4491	1.7	
Water Permeability	cm/sec	ASTM D 4491	0.4	
Water Flow Rate	gpm/ft^2	ASTM D 4491	120	
UV Resistance (500 hrs)	%	ASTM D 4355	>85	
pH			2 - 13	

3. Filter fabric shall be equal to TenCate Polyfelt TS 70

2.03 INITIAL BACKFILL

A. Initial backfill material shall be crushed stone as specified for bedding and haunching materials or earth material meeting the requirements of this section and the DWM Water and Sewer Design Standards.

2.04 FINAL BACKFILL

A. Final backfill material for unpaved areas shall be general excavated earth materials, shall not contain rock larger than two (2) inches at its greatest diameter, cinders, stumps, limbs, manmade wastes, and other unsuitable materials. If materials excavated from the trench are not suitable for use as

final backfill material, the Contractor shall provide select material conforming to the requirements of this section, including compaction requirements

B. Final backfill material for paved areas shall be crusher run. The **Contractor** shall install crusher run to the sub-base elevation in paved areas.

C. Material containing more than 10-percent gravel, stones, or shale particles is not acceptable.

2.05 SELECT BACKFILL

Select backfill shall be imported materials that meet the requirements as specified for bedding, haunching, initial backfill or final backfill materials, including compaction requirements.

2.06 CONCRETE

Concrete for bedding, haunching, initial backfill, or encasement shall have a compressive strength of not less than three thousand (3,000) psi, with not less than five and one-half (5½) bags of cement per cubic yard and a slump between three and five (3 and 5) inches. Ready-mixed concrete shall be mixed and transported in accordance with the requirements of ASTM C94. Reinforcing steel shall conform to the requirements of ASTM A 615, Grade 60.

2.07 FLOWABLE FILL

Flowable fill, where required for trench backfill, shall be submitted for approval and meet the requirements of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, Section 600 for Excavatable or Non-Excavatable type.

http://www.dot.ga.gov/PartnerSmart/Business/Source/specs/ss600.pdf#search=section%20600

The **Contractor** shall receive direction from the **Owner** on which type of flowable fill shall be used on a case-by-case basis.

A. Flowable fill is a mixture of Portland cement, fly ash, fine aggregate, air entraining admixture, and water. Flowable fill contains low cementitious content for reduced strength development.

B. Ensure flowable fill is manufactured at plants that qualify at approved sources according to the Standard Operating Procedure for Quality Assurance for Ready-Mix Concrete Plants in Georgia.

2.08 GRANULAR MATERIAL

Granular material, where required for trench backfill, shall be sand, river sand, crushed stone or aggregate, pond screenings, crusher run, recycled concrete, or other angular material. Granular material shall meet gradation requirements for Size No. 57. or finer.

2.09 COMPACTION EQUIPMENT

Compaction equipment shall be of suitable type and adequate to obtain the amount of compaction specified. Compaction equipment shall be operated in strict accordance with the manufacturer's instructions and recommendations and shall be maintained in such condition that it shall deliver the manufacturer's rated compaction effort.

PART 3 - EXECUTION

3.01 PREPARATION OF PIPELINE EASEMENT

A. Preparation of pipeline easement shall be performed in accordance with the requirements of **Section 02200 - Earthwork**. Where clearing or partial clearing of the easement is necessary, the **Contractor** shall clean the easement prior to the start of trenching. The **Contractor** shall cut trees and brush as near to the surface of the ground as practicable, remove all stumps, and pile for disposal. The **Contractor** shall not permit excavated materials to cover brush or trees prior to disposal.

   The **Contractor** shall not remove any trees without approval from the **Owner**.

B. Trees and shrubs farther than ten (10) feet from pipe centerline shall not be removed unless designated for removal by the **Owner** and within the easement. The **Contractor** shall protect all other trees and shrubs.

3.02 DISPOSAL OF CLEARED MATERIAL

The **Contractor** shall bear all costs of disposing of trees, stumps, brush, roots, limbs, and other waste materials from the clearing operation. Material shall be disposed of in such a manner as to meet all the requirements of Federal, State, and local regulations regarding health, safety, and public welfare. All cleared material shall be disposed of offsite in an approved location and at the **Contractor's** expense.

3.03 OBSTRUCTIONS

This item refers to obstructions that may be removed and do not require replacement. The **Contractor** shall remove obstructions within the trench area or adjacent thereto such as tree roots, stumps, abandoned piling, concrete

structures, logs, and debris of all types without additional compensation. The **Owner** may make changes in the trench alignment to avoid major obstructions, if such alignment changes can be made within the easement or right-of-way without adversely affecting the intended function of the facility. The **Contractor** shall dispose of obstructions removed from the excavation in accordance with the requirements of this section.

3.04 TRENCH EXCAVATION

A. Topsoil and grass shall be stripped a minimum of six (6) inches over the trench excavation site and stockpiled separately for replacement over the finished grading areas.

B. Trenches shall be excavated to the lines and grades shown on the Plans with the centerlines of the trenches on the centerlines of the pipes and to the dimensions that provide the proper support and protection of the pipe and other structures and accessories.

C. Trench Width for Pipelines:

1. The sides of all trenches shall be vertical, as much as possible, to a minimum of one (1) foot above the top of the pipe. Unless otherwise indicated on the Plans, the maximum trench width shall be equal to the sum of the outside diameter of the pipe plus two (2) feet. The minimum trench width shall be that which allows the proper consolidation of the haunching and initial backfill material.

2. The **Contractor** may, with the **Engineer's** approval, excavate the top portion of the trench to the maximum width within the construction easement or right-of-way that will not cause unnecessary damage to adjoining structures, roadways, pavement, utilities, trees, or private property. Where necessary to protect adjoining structures, roadways, pavement, utilities, trees, or private property, the **Contractor** shall provide sheeting and shoring. The **Contractor** shall use trench boxes to stabilize the trench meeting minimum structural loading. The **Contractor** shall ensure that all shop drawings from the supplier of the trench boxes have been stamped by a Professional Engineer registered in Georgia. The **Contractor** shall also submit to the **Engineer** for approval the sheeting and shoring.

3. Where rock is encountered in trenches, the **Contractor** shall excavate to remove boulders and stones to provide a minimum of six (6) inch clearance between the rock and any part of the pipe or manhole. The maximum allowable width of rock excavation for payment shall be the outer diameter of the pipe bell to be installed plus twenty-four (24) inches.

4. Wherever the prescribed maximum trench width is exceeded, the **Contractor** shall use the next higher Class or Type of bedding and

haunching as shown on the Plans for the full trench width as actually cut. The excessive trench width may be due to unstable trench walls, inadequate or improperly placed bracing and sheeting which causes sloughing, accidental over-excavation, intentional over-excavation necessitated by the size of the **Contractor's** tamping and compaction equipment, intentional over-excavation due to the size of the **Contractor's** excavation equipment, or other reasons beyond the control of the **Owner** and the cost is borne by the **Contractor**.

D. Depth:

1. The trenches shall be excavated to the required depth or elevation that allows for the placement of the pipe and bedding to the dimensions shown on the Plans.

2. Where rock is encountered in trenches for pipelines, the **Contractor** shall excavate to the minimum depth that shall provide clearance below the pipe barrel of eight (8) inches for pipe twenty-one (21) inches in diameter and smaller and twelve (12) inches for larger pipe and manholes. The **Contractor** shall remove boulders and stones to provide a minimum of six (6) inches clearance between the rock and any part of the pipe, manhole, or accessory.

E. Excavated Materials:

1. Excavated materials shall be placed a minimum of two (2) feet from the top edge of the open trench and may be used for backfilling as required. Topsoil shall be carefully separated and lastly placed in its original location.

2. Excavated materials shall not be placed in public roadways. Excavated materials not used or useful as backfill shall be immediately disposed of away from the site of the Work in accordance with the requirements of **Section 02200 - Earthwork**.

3. Excavated material shall be placed sufficiently back from the edge of the excavation to prevent caving of the trench wall, to permit safe access along the trench and not cause any drainage problems. Excavated material shall be placed so as not to damage existing landscape features or man-made improvements.

3.05 SHORING, SHEETING, AND BRACING OF TRENCHES

A. The **Contractor** shall sheet and brace the trench as required by Federal, State, and local laws and regulations. Shoring, sheeting, and bracing shall be designed by a Professional Engineer registered in the State of Georgia. OSHA standards shall be used to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the

public. The **Contractor** shall increase trench widths accordingly by the thickness of the sheeting. The **Contractor** shall maintain sheeting in place until the pipe has been placed and backfilled at the pipe zone. Shoring and sheeting shall be removed, as the backfilling is done, in a manner that shall not damage the pipe or permit voids in the backfill. All sheeting, shoring, and bracing of trenches shall conform to the safety requirements of the Federal, State, or local public agencies having jurisdiction. The most stringent of these requirements shall apply.

B. Sheeting, bracing, and shoring shall be performed in the following instances:

1. Where sloping of the trench walls does not adequately protect persons within the trench from slides or cave-ins.

2. In caving ground.

3. In wet, saturated, flowing, or otherwise unstable materials, the sides of all trenches and excavations shall be adequately sheeted, braced, and shored.

4. Where trenches and other excavations are within ten (10) feet from existing buildings and structures or where necessary to prevent damage to adjoining buildings, structures, roadways, pavement, utilities, trees, or private properties, which are required to remain, whichever is more stringent.

5. Where necessary to maintain the top of the trench within the available construction easement or right-of-way.

C. In all cases, excavation protection shall strictly conform to the requirements of the Occupational Safety and Health Act of 1970, as amended.

D. Timber: Timber for shoring, sheeting, or bracing shall be sound, free of large or loose knots, and in good, serviceable condition. Size and spacing shall be in accordance with OSHA regulations.

E. Steel Sheeting and Sheet Piling: Steel sheet piling shall be the continuous interlock type. The weight, depth, and section modulus of the sheet piling shall be sufficient to restrain the loads of earth pressure and surcharge from existing foundations and live loads. Procedures for installation and bracing shall be so scheduled and coordinated with the removal of the earth that the ground under existing structures shall be protected against lateral movement at all times. The **Contractor** shall provide closure and sealing between sheet piling and existing facilities.

F. Trench Shield: A trench shield or box may be used to support the trench walls. The use of a trench shield does not necessarily preclude the additional use of bracing and sheeting. When trench shields are used, care shall be taken to avoid disturbing the alignment and grade of the pipe or disrupting the haunching

of the pipe as the shield is moved. When the bottom of the trench shield extends below the top of the pipe, the trench shield shall be raised in 6-inch increments with specified backfilling occurring simultaneously. At no time shall the trench shield be "dragged" with the bottom of the shield extending below the top of the pipe.

G. The **Contractor** shall remove bracing and sheeting in units when backfill reaches the point necessary to protect the pipe and adjacent property. The **Contractor** shall leave sheeting in place when in the opinion of the **Owner** it cannot be safely removed or is within three (3) feet of an existing structure, utility, or pipeline. The **Contractor** shall cut off any sheeting left in place at least three (3) feet below the surface.

H. Sheet piling within three (3) feet of an existing structure or pipeline shall remain in place, unless otherwise directed by the **Owner**.

I. If, in the opinion of the **Owner**, the material furnished for supporting excavation is not of the proper quality or sufficient size, or not properly placed to insure the safety of the Work or of adjacent structures or property, the **Contractor** shall, upon notice by the **Owner**, forthwith procure and place satisfactory supports, or place said supports in a satisfactory manner and upon his failure so to do, the **Owner** may order the **Contractor** to stop work until said notice has been complied with and without entitling the **Contractor** to any claim for extra compensation, damage, or delay.

J. When required by the **Owner**, a shoring plan shall be submitted by the **Contractor** for approval prior to construction of the particular portion of the Work.

K. All supports in excavations shall be withdrawn in stages on both sides of trenches (to prevent lateral movement of the pipe) as the backfilling is being done, except where, and to such extent as the **Owner** shall order, or where the **Owner** shall permit the same to be left in place, at the **Contractor's** expense and upon the **Contractor's** request. The **Contractor** shall cut off any sheeting left in place, at least three (3) feet below finished grade whenever ordered by the **Owner**.

3.06 TRENCH ROCK EXCAVATION

A. Rock excavation shall be performed in accordance with the requirements of **Section 02200 – Earthwork** and as directed by the **Engineer**.

B. Definition of Trench Rock: Any material that requires drilling and blasting and occupies an original volume of at least one (1) cubic yard. Rock shall be considered as material that cannot be removed with a crawler tractor equal to a D-8 Caterpillar, equipped with a single-tooth ripper or by an excavator trackhoe

equal to a Caterpillar 225 rated with a ¾-cubic-yard capacity with a bucket curling pullout capacity of 25,000 pounds.

C. Blasting: Blasting shall be performed in accordance with the requirements of **Section 02020 – Use of Explosives** and will require County approval prior to use. The **Contractor** shall exhaust other practical means of excavating prior to utilizing blasting as a means of excavation. The **Contractor** shall provide licensed, experienced workmen to perform blasting. The **Contractor** shall conduct blasting operations in accordance with all existing ordinances and regulations and gain all required permits at their cost. The **Contractor** shall protect all buildings and structures from the effects of the blast. The **Contractor** shall repair any resulting damage. If the **Contractor** repeatedly uses excessive blasting charges or blasts in an unsafe or improper manner, the **Owner** may direct the **Contractor** to employ an independent blasting consultant to supervise the preparation for each blast and approve the quantity of each charge at the **Contractor**'s expense.

D. Disposal of Rock: The **Contractor** shall dispose of rock, off site, that is surplus or not suitable for use as riprap or backfill in a lawful manner.

E. The **Contractor** shall notify the **Owner** prior to any blasting. Additionally, the **Contractor** shall notify the **Owner** and local fire department before any charge is set.

F. The **Contractor** shall employ an independent, qualified specialty subcontractor, approved by the **Owner**, to: monitor the blasting by use of a seismograph; identify the areas where light charges shall be used; conduct pre-blast and post-blast inspections of structures, including photographs or videos; and maintain a detailed written log.

3.07 DEWATERING EXCAVATIONS

A. Dewatering shall be performed in accordance with the requirements of **Section 02140 - Dewatering.**

B. The **Contractor** shall dewater excavations continuously to maintain a water level at least two (2) feet below the bottom of the trench.

C. The **Contractor** shall control drainage in the vicinity of excavations so the ground surface is properly pitched to prevent water running into the excavation.

D. The **Contractor** shall maintain sufficient pumping equipment, in good working order, available at all times, to remove any water that accumulates in excavations. Where pipes cross natural drainage channels, the Work shall be conducted in such a manner that unnecessary damage or delays in the Work shall be prevented. The **Contractor** shall make provisions for the satisfactory disposal of surface water to prevent damage to public or private property.

E. In all cases, accumulated water in the trench shall be removed before placing bedding or haunching, laying pipe, placing concrete, or backfilling.

F. Where dewatering is performed by pumping the water from a sump, crushed stone shall be used as the medium for conducting the water to the sump. Sump depth shall be at least two (2) feet below the bottom of the trench. Pumping equipment shall be of sufficient quantity and/or capacity to maintain the water level in the sump at least two (2) feet below the bottom of the trench. Pumps shall be a type such that intermittent flows can be discharged. A standby pump shall be required in the event the operating pump or pumps clog or otherwise stop operating.

G. The **Contractor** shall dewater trenches by use of a well point system when pumping from sumps does not lower the water level at least 2 feet below the trench bottom. Where soil conditions dictate, the **Contractor** shall construct well points cased in sand wicks. A casing of six (6) to ten (10) inches in diameter shall be jetted into the ground, followed by the installation of the well point, filling the casing with sand, and withdrawing the casing.

3.08 TRENCH FOUNDATION AND STABILIZATION

A. The bottom of the trench shall provide a foundation to support the pipe and its specified bedding. The trench bottom shall be graded to support the pipe and bedding uniformly throughout its length and width.

B. If, after dewatering as specified above, the trench bottom is spongy, or if the trench bottom does not provide firm, stable footing, and the material at the bottom of the trench will still not adequately support the pipe, the trench shall be determined to be unsuitable and the **Contractor** shall then stabilize the trench by over-excavating the trench bottom and filling it with crushed stone.

C. Where the replacement of unsuitable material with crushed stone does not provide an adequate trench foundation, the trench bottom shall be excavated to a depth of at least 2 feet below the specified trench bottom. The **Contractor** shall place filter fabric in the bottom of the trench and support the fabric along the trench walls until the trench stabilization, bedding, haunching, and pipe have been placed at the proper grade. The ends of the filter fabric shall be overlapped above the pipe.

D. Where trench stabilization is provided, the trench stabilization material shall be compacted to a minimum ninety (90) percent of the maximum dry density, unless shown on the Plans or specified otherwise in these Specifications.

3.09 BEDDING AND HAUNCHING

A. Prior to placement of bedding material, the trench bottom shall be free of any water, loose rocks, boulders, or large dirt clods.

B. Bedding material shall be placed to provide uniform support along the bottom of the pipe and to place and maintain the pipe at the proper elevation. The initial layer of bedding placed to receive the pipe shall be brought to the grade and dimensions indicated on the Plans. All bedding shall extend the full width of the trench bottom. The pipe shall be placed and brought to grade by tamping the bedding material or by removal of the excess amount of the bedding material under the pipe. Adjustment to grade and line shall be made by scraping away or filling with bedding material. Wedging or blocking up of pipe shall not be permitted. 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. Each pipe section shall have a uniform bearing on the bedding for the length of the pipe, except immediately at the joint.

C. At each joint, the **Contractor** shall excavate bell holes of ample depth and width to permit the joint to be assembled properly and to relieve the pipe bell of any load.

D. After the pipe section is properly placed, the **Contractor** shall add the haunching material to the specified depth. The haunching material shall be shovel sliced, tamped, vigorously chinked, or otherwise consolidated to provide uniform support for the pipe barrel and to fill completely the voids under the pipe, including the bell hole. Prior to placement of the haunching material, the bedding shall be clean and free of any water, loose rocks, boulders, or dirt clods.

E. Gravity Sewers and Accessories: The **Contractor** shall lay pipe with Class "B" bedding, unless otherwise shown on the Plans, specified in these Specifications, specified by the manufacturer, or directed by the **Owner**.

1. Class "A": The **Contractor** shall excavate the bottom of the trench flat at a minimum depth as shown on the Plans, below the bottom of the pipe barrel. The **Contractor** shall lay pipe to line and grade on concrete block. The **Contractor** shall place concrete to the full width of the trench and to a height of one-quarter of the outside diameter of the pipe above the invert.

2. Class "B": The **Contractor** shall excavate the bottom of the trench flat at a minimum depth as shown on the Plans, below the bottom of the pipe barrel. The **Contractor** shall place and compact bedding material to the proper grade. Haunching material shall then be carefully placed by hand and compacted to provide full support under and up to the centerline of the pipe.

3. Class "C": The **Contractor** shall excavate the bottom of the trench flat at a minimum depth as shown on the Plans, below the bottom of the pipe barrel. The **Contractor** shall place and compact bedding material to the proper grade. Haunching material shall then be carefully placed by hand and compacted to provide full support under and up to a height of one-quarter the outside diameter of the pipe above the bottom of the pipe barrel.

4. Type 5: The **Contractor** shall excavate the bottom of the trench flat at a minimum depth as shown on the Plans, below the bottom of the pipe barrel. The **Contractor** shall place and compact bedding material to the proper grade before installing pipe. After the pipe has been brought to the proper grade, haunching material shall be carefully placed by hand and compacted to the top of the pipe.

F. Manholes: The **Contractor** shall excavate to a minimum of twelve (12) inches below the planned elevation of the base of the manhole. The **Contractor** shall place and compact crushed stone bedding material to the required grade before constructing the manhole.

G. Excessive Width and Depth:

1. Gravity Sewers: If the trench is excavated to excess width, the **Contractor** shall provide the bedding class with the next higher bedding factor. Type 5 Bedding may be used in lieu of Class "A" bedding, where Class "A" bedding is necessitated by excessive trench width.

2. If the trench is excavated to excessive depth, the **Contractor** shall provide crushed stone to place the bedding at the proper elevation or grade.

H. Compaction: Bedding and haunching materials under the pipe, manholes, and accessories shall be compacted to a minimum of ninety (90) percent of the maximum dry density, unless shown or specified otherwise in these Specifications.

3.10 INITIAL BACKFILL

A. Initial backfill shall be placed to anchor the pipe, protect the pipe from damage by subsequent backfill, and ensure the uniform distribution of the loads over the top of the pipe.

B. The **Contractor** shall place initial backfill material carefully around the pipe in uniform layers to a depth of at least twelve (12) inches above the pipe barrel. Layer depths shall be a maximum of six (6) inches.

C. The **Contractor** shall backfill on both sides of the pipe simultaneously to prevent side pressures.

D. The **Contractor** shall compact each layer thoroughly with suitable hand tools or tamping equipment.

E. Initial backfill shall be compacted to a minimum ninety (90) percent of the maximum dry density, unless shown or specified otherwise in these Specifications.

3.11 CONCRETE ENCASEMENT FOR PIPELINES

A. Where concrete encasement is shown on the Plans for pipelines, the Contractor shall excavate the trench to provide a minimum of twelve (12) inches clearance from the barrel of the pipe. The Contractor shall lay the pipe to line and grade on solid concrete blocks or solid bricks. In lieu of bedding, haunching, and initial backfill, the Contractor shall place concrete to the full width of the trench and to a height of not less than twelve (12) inches above the pipe barrel. The Contractor shall properly brace the pipeline in order to prevent floating of piping during concrete encasement placement. The Contractor shall not backfill the trench for a period of at least twenty-four (24) hours after concrete is placed.

3.12 FINAL BACKFILL

A. The **Contractor** shall backfill carefully to restore the ground surface to its original condition.

B. Except as specified otherwise in this section, the top six (6) inches shall be topsoil obtained as specified in this section.

C. Excavated material that is unsuitable for backfilling shall be disposed of in accordance with the requirements of **Section 02200 - Earthwork**.

D. If materials excavated from the trench are not suitable for use as backfill materials, the **Contractor** shall provide select backfill material conforming to the requirements of this section.

E. After initial backfill material has been placed and compacted, the **Contractor** shall backfill the trench with final backfill material. The **Contractor** shall place backfill material in uniform layers, compacting each layer thoroughly as follows:

1. In six (6) inch layers, if using light power tamping equipment, such as a "jumping jack"

2. In twelve (12) inch layers, if using heavy tamping equipment, such as hammer with tamping feet

3. In twenty four (24) inch layers, if using a Hydraram HARDOX-400 compactor.

F. Settlement: If the trench settles, the **Contractor** shall excavate, re-fill, compact, and grade the surface to conform to the adjacent surfaces.

G. Final backfill shall be compacted to a minimum ninety (90) percent of the maximum dry density, unless specified otherwise.

3.13 ADDITIONAL MATERIAL

A. Where final grades above the pre-construction grades are required to maintain minimum cover, additional fill material shall be as shown on the Plans. The **Contractor** shall utilize excess material excavated from the trench, if the material is suitable. If excess excavated materials are not suitable, or if the quantity available is not sufficient, the **Contractor** shall provide additional suitable fill material.

3.14 BACKFILL WITHIN RIGHTS-OF-WAY

A. The **Contractor** shall compact backfill underlying pavements and sidewalks, and backfill under dirt and gravel roads to a minimum ninety-five (95) percent of the maximum dry density.

3.15 BACKFILL WITHIN GEORGIA DOT RIGHTS-OF-WAY

Backfill within the GDOT rights-of-way shall meet the requirements stipulated in the "Utility Accommodation Policy and Standards," published by GDOT.

3.16 FLOWABLE FILL

A. Where flowable fill is required, and approved by the **Owner**, the **Contractor** shall excavate the trench to provide a minimum of six (6) inches clearance on either side of the pipe barrel. The **Contractor** shall lay the pipe to line and grade on solid concrete blocks or bricks. In lieu of bedding, haunching, and initial backfill, the **Contractor** shall place flowable fill to the full width and depth of the trench.

B. Flowable fill shall be protected from freezing for a period of thirty six (36) hours after placement. Minimum temperature of flowable fill at point of delivery shall be fifty (50) degrees F.

C. The **Contractor** shall provide steel plates over flowable fill in road locations.

3.17 COMPACTED GRANULAR MATERIAL

Where compacted granular material is required as initial and final backfill material, it shall be placed after bedding and haunching material specified elsewhere has been placed. Compacted granular material shall be compacted to a minimum ninety five (95) percent of the maximum dry density.

3.18 TESTING AND INSPECTION

A. The soils testing laboratory is responsible for the following:

1. Compaction tests in accordance with the requirements of this section.

2. Field density tests for each two (2) feet of lift, with at least one test site between each pair of manholes, every one hundred (100) feet within road rights-of-way, or more frequently if ordered by the **Owner**. The **Owner** will direct where the **Contractor** shall perform density tests along the site of the Work.

3. Inspecting and testing stripped areas, subgrades, and proposed fill materials.

B. The **Contractor**'s duties relative to testing shall include the following:

1. Notifying laboratory of conditions requiring testing.

2. Coordinating with laboratory for field-testing.

3. Paying costs for additional testing performed beyond the scope of that required and for re-testing where initial tests reveal non-conformance with specified requirements.

4. Providing excavation as necessary for laboratory personnel to conduct tests at no cost to the **Owner**

C. Inspection:

1. Earthwork operations, acceptability of excavated materials for bedding or backfill, and placing and compaction of bedding and backfill are subject to inspection by the **Engineer** and **Owner**.

2. Foundations and shallow spread footing foundations shall be inspected by **Engineer's** geotechnical personnel, who shall verify suitable bearing and construction.

D. The **Contractor** shall comply with applicable codes, ordinances, rules, regulations, and laws of local, municipal, state, or federal authorities having jurisdiction.

3.19 DISPOSAL OF EXCESS EXCAVATED MATERIAL

The **Contractor** shall dispose of excess excavated material, in accordance with the requirements of **Section 02200 - Earthwork**. The **Contractor** shall arrange for the disposal of excess materials, and shall bear all costs and expense of disposal.

+++ END OF SECTION 02324 +++

SECTION 02371
RIPRAP

PART 1 - GENERAL

1.01 SCOPE

A. Where shown on the Plans, specified in these Specifications, or directed by the **Owner**, the **Contractor** shall provide stone, sand-cement bag or grouted stone riprap, including associated earthwork, geotextile filter fabric, crushed stone, filter material, complete and in place. The type of riprap material will be as indicated on the Plans or directed by the **Owner**.

B. Related Work Specified Elsewhere:

1. Section 02060 - Crushed Stone Aggregate

2. Section 02200 - Earthwork

3. Section 02324 - Trenching and Trench Backfilling

4. Section 02125 - Temporary and Permanent Erosion and Sediment Control

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Requirements of the Contract Documents and **Section 01300 - Submittals**. In addition, the following specific information shall be provided:

1. Testing certificates from a qualified testing agency shall be submitted prior to acceptance of the rock source to verify conformity with the requirements of the Plans and these Specifications.

1.03 QUALITY ASSURANCE

A. 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. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

2. ASTM C535 - Standard Test Method for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

3. AASHTO T85 - Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.

4. AASHTO T210 - Method of Test for Aggregate Durability Index.

5. AASHTO T134 - Optimum Moisture Content.

6. Georgia Department of Transportation Standard Specifications Construction of Transportation Systems.

PART 2 - PRODUCTS

2.01 ROCK RIPRAP

A. Rock for riprap shall be sound, dense, durable stones, or rock fragments, free from cracks, pyrite intrusions, and other structural defects. Stones that will be used with mortar shall be free from dirt, oil, or other material that might prevent good adhesion with the mortar. Stones with a laminated structure shall be avoided. Field stones shall not be used as a source of rock for riprap. Only rock that has been approved by the **Engineer** shall be used for riprap.

2.02 STONES FOR RIPRAP

A. All stone for riprap shall be sound, durable pieces of quarried stone weighing one hundred and fifty-six (156) pounds per cubic foot or more. The stone shall be angular and random in shape. Rounded boulders or cobbles shall not be used. Flat, slabby, or shaley pieces shall not be acceptable. Stone shall be resistant to weathering and to water action and free from overburden, spoil, and organic material and shall meet the gradation requirements of this Section.

B. Riprap shall be of the type indicated on the Plans and shall conform to the size types as follows:

Type 1: equivalent to GA DOT specification for “Plain Riprap”:

Size by Volume	Approx. Weight	Percent Smaller Than
4.2 CF	700lbs	100%
1.8 CF	300lbs	50%-90%
0.8 CF	125lbs	20%-65%

Type 3: equivalent to GA DOT specification for “Dumped Riprap – Type 3”:

Size by Volume	Approx. Weight	Percent Smaller Than
1.0 CF	165lbs	100%
0.1 CF	15lbs	10%-65%

C. Stones shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

Durability Absorption Ratio	Acceptability
Greater than 23	Passes
10 to 23	Passes only if Durability Index is 52 or greater
Less than 10	Fails
Durability Absorption Ratio =	$\frac{\text{Durability Index (Coarse)}}{\%\ \text{absorption} + 1}$

D. The durability index and percent absorption shall be determined by AASHTO T 210 and AASHTO T 85, respectively. The minimum apparent specific gravity of the stones shall be two and one-half (2½) as determined by AASHTO T 85.

E. Stones shall have less than ten (10) percent loss of weight after five (5) cycles, when tested per ASTM C88.

F. Stones shall have a wear not greater than forty (40) percent, when tested per ASTM C535.

G. Control of gradation shall be by visual inspection. The **Contractor** shall furnish a sample of the proposed gradation of at least five (5) tons or ten (10) percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap. Any difference of opinion between the **Owner** and the **Contractor** shall be resolved by checking the gradation of two (2) random truckloads of stones. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking gradation shall be the **Contractor**’s responsibility.

H. The acceptability of the stones shall be determined by the **Owner** prior to final placement.

2.03 SAND-CEMENT BAG RIPRAP

A. Portland Cement shall meet the requirements of State of Georgia Standard Specifications Construction of Transportation Systems, Section 830 - Portland Cement (reference AASHTO M85).

B. Fine Aggregate shall meet the requirements of State of Georgia Standard Specifications Construction of Transportation Systems, Section 801 - Fine Aggregate. The aggregate shall be composed of hard, durable particles, free from injurious amounts of organic impurities. The aggregate shall have no more than twenty (20) percent passing the No. 200 sieve and the material passing the No. 10 sieve shall not be more than seven (7) percent clay.

C. Bags shall be of cotton, burlap, or fiber reinforced paper capable of containing the sand-cement mixture without leakage during handling or placing. Bags previously used for sugar or any other material which will adversely affect the sand-cement mixture shall not be used. Capacity of bags shall not be less than three - quarters (¾) cubic foot minimum nor more than two (2) cubic feet maximum.

2.04 GEOTEXTILE FABRIC FILTER

A. Geotextile fabric shall meet the requirements of State of Georgia Standard Specifications Construction of Transportation Systems, Section 881 – Fabrics, for woven fabrics, having physical properties as follows:

Tensile Strength – any direction (ASTM D 4634)	200 lbs
Bursting Strength (ASTM D 3786)	500 psi
Elongation Before Breaking (ASTM D 4634)	10 – 35%
Percent Open Area (GDT: 88)	4.0 – 6.0%

B. Fabric shall be TenCate Mirafi Filterweave FW403 or approved equal.

2.05 STONE FILTER MATERIAL

A. Stone Filter material shall be clean and free from organic matter. It shall be crushed rock or gravel, durable, and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall conform to the following gradation (State of Georgia Standard

Specifications Construction of Transportation Systems, Section 800 - Coarse Aggregate, No. 467 modified):

Size	Percentage Passing
2 inch	100
1½ inch	95-100
¾ inch	35-70
⅜ inch	10-30
No. 4 Sieve	0-10

PART 3 - EXECUTION

3.01 GENERAL

A. All slopes to be treated with riprap shall be trimmed to the lines and grades indicated on the Plans or as directed by the **Engineer**.

B. Unless otherwise indicated on the Plans or directed by the **Engineer**, stone riprap shall not be placed on slopes steeper than the natural angle of repose of the riprap.

3.02 SURFACE PREPARATION

A. Surfaces to receive filter materials and riprap, including the toe trench and slope, shall be brought to the line and grade indicated on the Plans and shall be smooth and firm, free of brush, trees, stumps, and other objectionable material. Where filling of depressions is required or a filled bank is constructed, the new material shall be compacted with hand or mechanical tampers to a minimum of eighty-five (85) percent of maximum density.

B. Riprap shall be placed in dry conditions. The **Contractor** shall remove and exclude all stormwater, groundwater, and creek or stream water from the excavation. Sump pumps and sand bags or portable dams, diversions, or other approved means, shall be used to remove and exclude water and continuously maintain water level below the bottom of the excavation. Water shall be removed and excluded until both geotextile and stone filter material and riprap have been placed. Any water removed from the excavation shall not be discharged into any surface stream or other water body unless such discharge meets water quality standards. Removed water may be disposed on-site by land application using sprinklers in an area designated by the **Engineer** or by discharge into an approved treatment system.

C. Where the **Owner** approves for the toe trench to be constructed under water, the following construction practices, or approved equivalent practices, shall be observed:

1. The **Contractor** shall use a U.S. Army Corps of Engineers-approved floating silt fence, or alternative approved method, surrounding the construction area to maintain adjacent water turbidity within applicable permit limits.

2. The **Contractor** shall measure the depth below water of the existing stream bed and submerged bank along the entire toe length, using a calibrated surveyor's rod or equivalent tool.

3. The **Contractor** shall then excavate material until the required trench section has been excavated. Confirmation that the required toe trench depth has been achieved shall be established by the **Contractor** through repeated measurement with the surveyor's rod.

4. In areas where the Plans show the use of geotechnical fabric or where directed by the **Owner**, geotextile fabric shall then be laid, as described in this section, and temporarily held in place until riprap can be positioned to hold the fabric permanently.

5. In areas where the Plans show the use of stone filter material, or where directed by the **Owner**, stone filter material shall be placed to the specified thickness and leveled to the extent practical, using the surveyor's rod to verify required depth and level.

D. Cleared and excavated materials shall be hauled off site to an appropriate disposal location arranged by the **Contractor** and at its sole expense unless otherwise indicated on the Plans or specified in these Specifications.

E. Riprap installed at the toe of a stream bank below the elevation of the water in a stream to prevent scour from undermining the riprap shall be backfilled and covered with native soil to the original grade. The backfilled native soil shall be compacted with hand or mechanical tampers to a minimum of eighty (80) percent of maximum density.

3.03 CREEK CROSSINGS

A. Riprap shall be installed at all creek and storm drain crossings, at creek entrance into culverts or headwalls in accordance with the Plans, Standard Details, or these Specifications. The dimensional width of the riprap material at creek or storm drain crossings shall be equal to the trench width cut to install the pipeline plus six (6) feet or as directed by the **Owner**. The method of installation shall be in accordance with the requirements of this section.

B. Installation of riprap shall be kept up as closely as possible with the progress of pipe laying so as to perform the work in a uniform workmanlike manner.

3.04 PLACEMENT OF GEOTEXTILE FABRIC

A. The fabric shall be placed with the long dimension running up the slope, with the upstream strip overlapping the downstream strip. The **Contractor** shall use a minimum of two (2) foot overlap for each overlap. The **Contractor** shall use a wider overlap if recommended by the geotextile manufacturer.

B. The fabric shall be placed loosely with sufficient folded or gathered material to prevent stretching and tearing during riprap placement.

C. The fabric shall be anchored into place using securing pins with type and spacing as recommended by the manufacturer. In addition, the fabric shall be secured at the toe and crest of the slope using anchor trenches at least two (2) feet deep. If a stream bank extends sufficiently above a stream such that riprap would not be installed to the top of the bank, then the fabric shall be anchored in a two (2) foot deep trench up-slope from the top of the minimum free-board of one-half (½) foot above the flow resulting from a fifty (50) year, twenty four (24) hour storm runoff event.

3.05 PLACEMENT OF STONE FILTER MATERIAL

A. Stone filter shall be uniformly placed to a tolerance of plus or minus one-half (½) inch and to a thickness of twelve (12) inches for Type 2 riprap and eight (8) inches for Type 3 riprap.

B. Stone filter material shall be compacted to a minimum relative density of eighty (80) percent.

3.06 CONSTRUCTION METHODS

A. All riprap construction shall begin at the bottom of the slope and progress upward.

B. The **Contractor** shall place riprap using methods and equipment approved by the **Owner**. The methods and equipment used to place riprap shall be suitable for the class or type of riprap involved. If the finished riprap emplacement installed using the **Contractor**'s method is not satisfactory, the **Owner** reserves the right to have it removed and replaced using hand placement methods and fresh stone.

C. Unless otherwise indicated on the Plans or directed by the **Owner**, plain rock riprap shall be constructed using a crane and clam-shell or other suitable equipment approved by the **Owner**. The rock shall be placed as nearly as practicable in final position using powered equipment. If necessary, larger rocks shall be worked up to the surface when the material on the surface does not meet the weight specifications or when the voids next to the foundation material are too large.

D. The quantity of small stones shall be kept as low as possible, sufficient only to fill the voids between the larger stones. Care shall be taken to ensure that small stones are well distributed throughout the mass and not allowed to segregate or form pockets of small stone. All bridging shall be broken down. Large interstices, or open channels, or voids shall be filled by chinking or otherwise manipulating the stones.

E. When riprap is to be built on existing riprap, special care shall be taken to provide positive anchorage of the new riprap to the existing riprap.

F. The finished riprap surface shall in general conform to the slope lines shown on the Plans. No objectionable, hazardous, or unsightly projections above the general plane surface shall be permitted.

G. The main stones shall be thoroughly chinked and filled with the smaller stones by throwing them over the surface in any manner that is practicable for the smaller stones to fill the voids. This work shall continue with the progress of the construction. Tamping of the stones will not be required if the stones have been placed in a reasonable and satisfactory manner.

H. Knapping of the stones will not be required except stone protruding more than four (4) inches above what is considered the normal surface of the stones, in which case these stones shall be broken down to come within four (4) inches of the normal surface.

3.07 SAND-CEMENT BAG RIPRAP

A. Fine aggregate and Portland cement shall be mixed at a maximum ratio of 5:1 by weight. The amount of water added shall be just enough to achieve optimum moisture content of the aggregate and cement, as determined by AASHTO T134.

B. The cement mixture shall obtain a minimum compressive strength of five hundred (500) psi in seven (7) days.

C. The bags shall be uniformly filled and tied in accordance with applicable permits. The bags shall be placed by hand with tied ends all facing the same direction.

D. The bags shall be packed against one another to produce the desired thickness and form a consolidated mass. Bags shall be placed to the elevation specified or indicated on the Plans to a tolerance of plus or minus three (3) inches. After the bags are placed, the riprap structure shall be kept wet by sprinkling or covering with wet material for at least three (3) days. The sand-cement bags shall be protected from stream water or any disturbance during this curing period, and shall not be placed in freezing weather or when conditions are unfavorable for curing.

3.08 GROUTED RIPRAP

A. After the riprap has been placed, the stones shall be thoroughly wetted before grouting. The spaces between the stones shall then be filled with a well-mixed grout composed of one (1) part Portland cement and three (3) parts of sand mixed with sufficient water to achieve a workable consistency. The grout shall be placed beginning at the toe and proceeding up the slope, and shall be finished by sweeping with a stiff bristle broom. After the grouting is completed, the structure shall be kept wet by sprinkling or covering with wet material for at least three (3) days. The grout shall be protected from stream water or any other disturbance during this curing period, and shall not be placed in freezing weather or when conditions are unfavorable.

3.09 CLEANUP

A. After completion of the riprap construction, the **Contractor** shall remove all debris and construction materials and equipment from the construction area and leave the entire construction area clean, neat, and in serviceable condition. The **Contractor** shall restore the construction area to the original or better condition in accordance with the requirements of **Section 02920 - Site Restoration**.

+++ END OF SECTION 02371 +++

SECTION 02405
BLASTING

PART 1 – GENERAL

1.01 SCOPE

A. This Section covers the work necessary for the use of explosives and blasting in connection with rock excavation for pipelines, meter vaults, wet wells, retaining walls, and for other excavations required for completion of the Work.

B. Specifications in this Section govern blast design, blast limitations, explosive materials, equipment, labor and supervision for transportation and storage of explosives, drilling and loading of blast holes, protection of existing facilities, test blasts, and damage repairs due to **Contractor's** blasting operations.

C. Limit the use of explosives in the work to the practicable minimum by utilizing mechanical means of excavation to the maximum feasible extent. Blasting shall be limited and shall be approved by the **Owner and Engineer**.

No Blasting shall occur until the Contractor has received written approval from Owner. The Contractor shall notify Owner in writing the date, time of day of the first blast and the duration the blasting is to occur.

D. Related Work Specified Elsewhere:

1. Section 01714 - Pre-Construction & Post-Construction Inspections and Surveys
2. Section 02000 - Site Work
3. Section 02140 - Dewatering
4. Section 02200 - Earthwork
5. Section 02324 - Trenching and Trench Backfilling

1.02 GENERAL

A. Perform blasting only with permits from the appropriate jurisdictional agencies. Necessary permits include an Explosives License issued by the Georgia Safety Fire Commissioner, and users' permits obtained from **Owner**. Obey all local, State, Federal and other Governmental regulations applying to transportation, handling, storage and use of explosives, including the requirements of the Spalding County Fire Department, the State of Georgia and applicable regulations of the Occupational Safety and Health Administration.

B. Perform blasting operations in trenches, shafts and other open excavations only during daylight hours. Perform blasting operations only during the hours approved by the **Owner**. No blasting shall be performed on Saturdays, Sundays or on the public holidays observed by the **Owner**. If an emergency prevents a blast being fired during the permitted hours and the holes are loaded, the blast shall be fired as soon as safety allows. In the event that blasting is found necessary outside the permitted hours, the **Contractor** shall receive approval from the **Owner** and inform local residents within hearing and vibration range and the jurisdictional agencies prior to firing.

C. Furnish, install, and operate at each site where blasting is being performed, using electric methods of initiation, an approved short-range, high accuracy thunderstorm monitor and lightning warning system. System shall constantly be monitoring the electrical field of the atmosphere for pre-emptive notification of nearby lightning strikes. The system shall connect to system lighting and audible devices to alert of incoming lightning activity. The system shall have the capability to send test messages and email alert notifications. The system shall have adequate provisions for transmitting alarms from the device to all locations where preparation for blasting, using electric initiation, is in progress. Install and maintain the system in accordance with the manufacturer's recommendations. Test the entire monitoring and alarm system for satisfactory operation at intervals not exceeding two (2) weeks and suspend blasting operations until any defects have been corrected.

D. Employ the services of a blasting consultant, satisfactory to the **Owner** and experienced in predicting and evaluating the effects of blasting on nearby structures, such that vibration levels at these structures do not exceed a level that will damage the structures or their contents or cause undue alarm to their occupants. Employ the blasting consultant to plan and evaluate blasting operations.

E. Preconstruction Video Survey and Inspections

1. **Contractor** is expressly advised that the protection of buildings, structures, bridges, utilities, and related work adjacent and in the vicinity of its operations, wherever they may be, is solely its responsibility. Existing condition inspection of buildings, bridges, or other structures in the immediate vicinity of any blasting operations shall be performed by and be the responsibility of the **Contractor**. The inspection corridor shall extend within a 500-foot radius of all proposed blasting operations. The **Contractor** shall retain an independent consultant, specializing in preconstruction surveys, to conduct the required inspections. The video survey and inspections shall conform to the requirements of:

    a. Section 01714 - Pre-Construction & Post-Construction Inspections and Surveys.

2. Prior to the start of blasting operations, the **Contractor** shall have the independent preconstruction survey consultant, make an examination of the interior and exterior of the adjacent structures, buildings, facilities, etc., and record by notes, measurements, photographs, etc., conditions which might be aggravated by blasting or other operations. Repairs or replacement of all conditions disturbed by the construction shall be made to the satisfaction of the owners or agents of adjacent buildings, structures, facilities, etc., and to the satisfaction of the **Owner**. This does not preclude conforming to the requirements of the insurance underwriters. Two (2) copies of surveys, photographs, videos, reports, etc., shall be submitted to the **Owner**.

3. The cost of all pre-construction video surveys and inspections shall be borne by the **Contractor**.

1.03 DEFINITIONS

A. Air-Overpressure: Temporary changes in ambient air pressure caused by blasting. Air-overpressure is expressed in units of psi or dB. Measurements for blasting are made with microphones having a flat frequency response for over-pressure in the 2 to 200 Hz range. A-weight or C-weight microphones shall not be used for these measurements.

B. Buffer Holes: Holes with reduced energy charges drilled adjacent to smoothwall, trim or open line-drilled holes at the perimeter of the excavation. The explosive charge in buffer holes is generally between 50 and 75 percent of the charge used in normal production blastholes. Buffer holes are usually drilled parallel to adjacent holes at the excavation perimeter.

C. Charge-per-Delay(W): For purposes of vibration control, any charges firing within any 8-millisecond time period are considered to have a cumulative effect on vibration and air-overpressure effects. Therefore, the maximum charge-per-delay equals the sum of the weight of all charges firing within any 8-millisecond time period. For example, if two 10 lb. charges fire at 100 ms and one 15 lb. charge fires at 105 ms, the maximum charge per delay would be 35 lbs.

D. Controlled Blasting: Excavation in rock in which the various elements of the blast, including hole size, position, alignment, depth, spacing, burden, charge size, distribution and delay sequence are carefully controlled to excavate the rock to the desired lines with a relatively uniform surface with minimal overbreak and fracturing of rock beyond the design excavation limits and to maintain resulting noise, overpressure and peak particle velocity within specified maximum limits.

E. Delay: Distinct pause of pre-determined time between detonations of single charges or groups of charges.

F. Geotechnical Baseline Report (GBR): A geotechnical report that provides a description of the subsurface conditions and interpretive information on the behavior of soils and groundwater conditions anticipated during construction.

G. Geotechnical Data Report (GDR): A geotechnical report that presents geotechnical data that is collected during subsurface investigations. This report presents the actual boring and laboratory data of the soil and groundwater conditions present in the immediate area of investigation.

H. Line Drilling: A method of controlling overbreak, in which a series of very closely spaced holes are drilled at the perimeter of the excavation. Line holes are generally not loaded with explosives; however, in some applications alternating holes may be loaded with light charges using detonating cord.

I. Occupied Building: Structure on or off construction limits that is occupied by humans or livestock.

J. Peak Particle Velocity (PPV): The maximum of the three ground vibration velocities measured in the vertical, longitudinal and transverse directions. Velocity units are expressed in inches per second (ips).

K. Pre-splitting: A blasting technique in which the perimeter charges are detonated first in the firing sequence or as a separate blast ahead of production blasting. This technique is designed to generate a fracture in the plane of the pre-split holes drilled along the perimeter of the excavation.

L. Primary Initiation: The method whereby the blaster initiates the blast(s) from a remote and safe location. Primary initiation systems use pneumatic tubing or shock-tubes to convey firing energy from blasters to blast locations.

M. Production Holes: Blast holes in the main body of the rock mass being removed by drilling and blasting.

N. Prohibited Persons: Persons prohibited from handling or possessing explosive materials as defined by the seven categories described in Section 555.11 of 27 CFR ATF Rules).

O. Residential Building: Includes single and multi-family dwellings, hotels, motels and any other structure containing sleeping quarters.

P. Scaled Distance: A factor describing relative vibration energy based on distance and charge-per-delay. For ground vibration control and prediction purposes, Scaled Distance (Ds) is obtained by dividing the distance of concern (D) by the square root of the charge-per-delay (W) - $Ds=D/(W)^{½}$.

Q. Smoothwall Blasting (Trim Blasting): A controlled blasting technique used to produce smooth walls in a shaft, intake chamber or tunnel. The trim holes are located around the perimeter of the excavation but not along the tunnel floor or sidewall holes lower than 3 feet from the tunnel floor. Trim charges are decoupled to reduce the linear charge density and are placed in holes with reduced spacing and are fired after the main charge.

R. Stemming: Crushed stone, tamped clay or other inert earth material placed in the unloaded collar area of blastholes for the purpose of confining explosive charges and limiting rock movement and air overpressure.

S. Sub-drilling: The portion of the blasthole that is drilled below or beyond the desired excavation depth or limit. Subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blastholes.

T. Surface Blasting: All excavations where surface blasting techniques are required.

1.04 REFENCE STANDARDS

A. U.S. Department of Justice, Alcohol, Tobacco and Firearms and Explosives Division (ATF27 CFR Part 555, Implementation of the Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296; Interim Final Rule).

B. Institute of Makers of Explosives

1. Dos and Don'ts - Instructions and Warnings for Consumers in Transporting, Storing, Handling, and Using Explosive Materials

2. Destruction of Commercial Explosives

3. Suggested Code of Regulations for the Manufacture, Transportation, Storage, Sale, Possession and Use of Explosive Materials

4. Safety in the Transportation, Storage, Handling and Use of Explosive Materials

5. Safety Guide for the Prevention of Radio Frequency Radiation Hazards in the Use of Electric Blasting Caps.

C. National Fire Protection Association (NFPA)

1. NFPA 495 - Code for the Manufacture, Transportation, Storage and Use of Explosive Materials, 1985 Edition

2. NFPA 498 - Standard for Explosives, Motor Vehicle Terminals, 1985

Edition

D. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Construction Standards and Interpretations 29 CFR Part 1926, Subpart U, Section 1926.900, “Blasting and Use of Explosives”, final rule dated December 16, 1972.

E. Official Code of Georgia (OCGA); Code Section 25 - Georgia Blasting Standards Act of 1978, Code Section 25-9-1, et seq.

F. Vibration Subcommittee of the International Society of Explosive Engineers (ISEE), blast monitoring equipment operation standards (1999).

1.05 QUALITY CONTROL

A. The design and execution of blasting shall be performed under the on-site supervision of a licensed blaster certified in the State of Georgia.

B. The **Contractor** shall perform blast monitoring as required to satisfy its legal obligation relative to all permits and all applicable federal, state and local codes, laws, regulations and ordinances, and its contractual responsibilities, including safety.

C. The **Owner** may perform blast monitoring to verify conformance with regard to air-overpressure (noise) and peak particle velocity criteria defined by this Section.

D. Qualifications and Clearance Status:

1. The blasting supervisors (blasters-in-charge) shall have a minimum of five (5) years’ experience, directly related to the specific types of excavation blasting they will oversee. All blasting supervisors shall be able to document the completion of at least three projects of similar scope and complexity.

2. All blasters and supervising shift foremen shall be properly qualified and licensed in accordance with applicable federal, state and local government regulations. Necessary permits include an Explosives License issued by the Georgia Fire Safety Commissioner.

3. Retain the services of an experienced blasting consultant with at least ten (10) years’ experience in monitoring blasting operations (test blasts and production blasts), interpreting ground vibration, air overpressure, and impulse amplitudes for similar construction projects, and to prepare all blasting plans, test-blasting plans, and revisions to any of these plans. All blasting plans, test-blasting plans and revisions shall be reviewed by and

covered with a signed review letter by the blasting consultant. The blasting consultant will not be required to sign the individual blast plans provided they are signed by an on-site licensed blaster.

4. The blasting consultant shall be on call throughout the entire period that blasting is performed and shall be available at the site within two (2) days at any time that the blasting consultant's services may be necessary as determined by the **Owner**.

5. All persons that handle explosive materials, have control over them, or access to them, must not be prohibited persons, as defined in Section 555.11 of 27 CFR (ATF Rules).

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Requirements Conditions of the Contract Documents and **Section 01300 - Submittals**. In addition, the following specific information shall be provided:

1. At least sixty (60) days prior to commencement of blasting operations, a copy of all applicable licenses and permits for the purchase, transportation, storage and use of explosives.

   a. Submitted permits must include a copy of Federal ATF blasting license listing all responsible persons, blasting use and storage permits issued by the Georgia State Fire Marshals Office, and any other necessary local permits.

   b. No explosives can be brought to any work sites until all necessary permits have been submitted to the **Engineer.**

2. At least sixty (60) days prior to commencement of blasting operations, a Blasting Monitoring Plan that shall include:

   a. Name of the Blasting Vibration Consultant who shall be responsible for establishing the monitoring program and interpreting the vibration readings.

   b. Names of the trained personnel provided to operate the monitoring equipment; the type and model of blasting seismograph proposed for use.

   c. Number and location of proposed monitoring stations; the methods to be used to coordinate blast detonation with recording of the blast.

   d. Steps to be taken if blasting vibrations exceed or seem likely to exceed the vibration limits.

e. Name, make, and model of the short-range, high accuracy thunderstorm monitor and lightning warning system, including details on the alert warning system.

3. At least sixty (60) days prior to any blasting operation, provide:

   a. Initial blast design for that location including number, location, diameter, depth and inclination of drill holes on a scale drawing of the excavation or heading face.

   b. Type and weight of explosive in each hole; delay arrangement showing delay period in each hole; total weight of explosive in the blast and maximum charge per delay; the method of detonation; calculations of peak particle velocities and air blast overpressures; and the precautions to be taken to prevent flying rock or other debris.

   c. Manufacturers' data sheets shall be provided for all explosives and accessories to be used.

   d. Name and qualifications of the independent preconstruction survey consultant.

   e. Preconstruction Video Survey and Inspections.

   f. Written controlled blasting techniques.

   g. Description of and locations of signage used to announce blast warning signals to any persons that might enter the blast area.

   h. Specific measures taken to protect structures, buried utilities, and other facilities that may be potentially affected by blasting operations.

   i. Prediction calculations for noise (air-overpressure) and peak particle velocity (PPV) at the closest structure and at other adjacent structures, pipelines, or facilities that may be potentially affected by blasting operation.

4. At least thirty (30) days prior to any blasting operation, provide Blasting Safety Plan including:

   a. Health and Safety requirements of all governing legislation.

   b. Certificates from all regulating agencies and relevant insurance companies.

   c. Outline of blasting and fire safety training programs for the **Contractor**'s and **Owner**'s personnel.

d. Communication and warning procedures.

e. Samples of all report and inspection forms.

f. Lightning protection plan.

g. Contingency plans for handling misfires.

h. Fire prevention plan details, including firefighting and evacuation plans.

i. Detailed description of how explosives will be safely stored, transported, and used at the various work sites. This plan shall also indicate how explosives will be inventoried, secured, and guarded to prevent theft or unauthorized use of explosives.

5. At least fourteen (14) days prior to any blasting operation, provide Regulations including:

a. At least two (2) copies of all applicable federal, state and local codes, laws, regulations and ordinances regarding the use of explosives. One copy of these codes, laws, regulations and ordinances shall be submitted to the **Owner**. The second copy shall be maintained on-site in the **Contractor's** office, for review by all **Contractor** personnel involved in blasting.

6. Within the working day following each blast, the **Contractor** shall provide the blasting records and information for each blast detonated:

a. A complete description including the location, date and exact time of the blast; name and signature of person in responsible charge of loading and firing and their blaster permit number; details of each blast as listed above for the initial blast design and any departures from the blast design; comments regarding any misfires, unusual results or unusual effects; any other records required by applicable regulations; and the name and signature of the person preparing the report.

b. The monitoring record including the location, date, and exact time of the blast; general weather conditions; the locations of seismographs and type of ground on which they were located, instrument identification and their distances from the blast; the measured peak particle velocities; air blast overpressure records, if appropriate; and the name and signature of the observer.

7. Maintain a record of each blast detonated. Submit to the **Owner** the following records and information the same day the blasting is performed:

a. Depth of blast holes and the location of the blast point in relation to Project stationing;

b. Type, strength and quantities of all explosives, types and quantities of detonators, powder factor (lb/cy), and actual firing times of all charges;

c. Total explosive loadings per round and maximum charge per delay;

d. Type of rock blasted;

e. Reference to approved blast design submittal noting any modification;

f. Time spent scaling rock and approval of rock scaling by designated individual;

g. On a diagram of the approved blast pattern indicate any holes not drilled, drilled but not loaded, changes in spacing or in pattern of delay charges or in loading of holes. Include notes explaining why changes were made;

h. Submit an evaluation of the blast indicating tights, areas of significant overbreak and any recommended adjustments for future blasts;

i. Comments by the blaster in charge regarding any misfires, unusual results, or unusual effects;

j. Date and exact firing time of blast; name of person in responsible charge of loading and firing and blaster permit number;

k. Signature and title of person making recording entries;

l. Record of peak overpressure: Two copies of all blast vibration monitoring data obtained independent of monitoring performed by the **Engineer**. Submit hard copies of 4-channel waveforms for each blast;

m. Any other records required by federal, state and local codes, laws, regulations and ordinances.

8. Submit Post-construction Video Survey and Inspections once blasting is completed for each site.

1.07 NOTIFICATION

A. For all work sites prior to starting blasting, the **Contractor** shall notify the appropriate local municipal officials, above- and below-ground utility owners, and the **Owner** who will notify the general public expected to be potentially affected, of the **Contractor**'s intent to conduct controlled blasting operations. Notice shall be given to all operators of all buried pipes, cables, conduits, and overhead utility lines and poles located within a 200-foot radial distance of the blast area.

B. Notification to appropriate local municipal officials and utility owners or

operators shall be done in writing, at least 48 hours prior to the start of blasting at a particular site or sooner if so required by any applicable local law or regulation, and shall indicate the expected frequency of blasting, hours that blasting might occur, and the expected date that blasting will be completed. Upon completion of blasting at the particular site, utility owners or operators shall be notified that blasting has ceased in the area for the duration of the Project.

C. The **Contractor** shall furnish the **Owner** with a list of those parties notified in accordance herewith prior to the start of such blasting. The list shall include names, addresses, and telephone numbers.

D. The **Contractor** must submit copies of written notification letters sent to the responsible fire protection agency for any sites where explosives are stored overnight. These letters shall be submitted to the **Owner** at least 48 hours before any explosives are stored at the site. These letters must be submitted by the **Contractor** to the responsible fire protection agency, 48 hours before explosives are stored at the site.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver all explosives to magazines by land transportation in accordance with all applicable federal, state and local codes, laws, regulations and ordinances.

B. Storage of Explosives

1. Transportation, use and storage of explosives shall be as prescribed by the most stringent of the rules promulgated by all federal, state and local codes, laws, regulations and ordinances, and these Specifications.

2. Initiation devices shall not be stored, transported, or kept in the same place in which other explosives are stored, transported, or kept.

3. Only those explosive materials required for a 24-hour period shall be allowed at the construction sites. Storage of explosives during non-blasting periods is not permitted and the day-storage magazine shall be empty during these periods. If storage permits are obtained, the maximum amount of explosives must not exceed limits set by ATF rules (American Table of Distances).

4. Provide a dedicated on-site vehicle that meets all applicable DOT and OSHA standards regarding the transportation of explosive materials from the magazine to the shaft collar or blasting site. Records shall be maintained that clearly show quantities and types of all explosive materials and detonators received from suppliers and returned to them. The differences in received and returned quantities must accurately

correspond with the amounts reported in blasting records.

5. No statement in these Specifications shall be considered to relieve the **Contractor** from sole responsibility for the safe transportation, use and storage of explosives.

1.09 GROUND CONDITIONS

A. A subsurface investigation was not performed and one will not be available as part of the Contract Documents for the Pipelines Project (Contract A).

B. A subsurface investigation was performed for the Lift Stations Project (Contract B) to develop the basis of design criteria provided on the Drawings. The GDR and GBR are not included as part of the Contract Documents.

C. The **Contractor** shall be responsible for obtaining GDR and GBR for each of the Pipelines (Contract A) and Lift Stations (Contract B) Projects for use during construction activities.

1.10 JOB CONDITIONS

A. Extra caution and skill will be required to accomplish the Work in a satisfactory manner. Blasting must be safely performed in close proximity to residential communities and other structures. Effects of blasting must also be controlled to maintain the integrity of the grouted rock adjacent to the tunnel and shaft excavations to minimize groundwater inflows. The **Owner** will exercise its prerogative to examine carefully the qualifications of any persons whose knowledge and skills may bear on the outcome of the Work. In addition, the **Owner** may reject any person who is deemed unqualified for any tasks that may be required.

B. Methods of construction shall be such as to ensure the safety of the Work, Project participants, the public, third parties, and adjacent property, whether public or private. All work shall comply with all federal, state and local codes, laws, regulations, and ordinances. The **Contractor** is solely responsible for maintaining safe working conditions at the jobsite at all times.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Use only non-nitroglycerine explosives.

B. Only explosive and initiation devices packaged by federally-licensed explosives manufacturing firms shall be used in blasting. All explosives and Blasting agents to be used underground shall meet the Fume Class I requirement of the Institute of Makers of Explosives (IME). This restriction does not apply to detonation cords that may be used for trunk lines or in controlled perimeter

blasting charges. Only packaged or cartridge type, non-flowing explosives shall be used in the works. Black powder and nitroglycerine are prohibited for all blasting.

C. Non-electric detonating devices shall be used.

D. Only explosives designed and manufactured for smoothwall (trim) blasting shall be used in perimeter holes for blasting in the shafts, tunnels and diversion structure excavations. The linear charge-weight-per-foot of explosives used in shaft perimeter and tunnel back and rib holes shall not exceed 0.4 lb/ft. This limitation does not apply to the primer stick, which must not weigh more than 0.5 pounds. Cartridge configurations and detonating cord shall be included in the linear charge weight-per-foot.

E. Explosives, blasting agents, primers, initiators, and ancillary blasting materials shall be kept in original packaging with clearly marked date codes. All explosives and initiating devices used shall be less than one (1) year old. Blasting products shall not be brought onto the site if the date codes are missing.

F. If the **Owner** determines that a blasting product appears to be in a damaged or deteriorated condition, the suspect product shall not be used until its condition can be determined. Products found to be damaged or in a deteriorated condition shall be immediately returned to the supplier for safe disposal.

2.02 EQUIPMENT

A. Use dust suppressant measures with air-powered or air-flush rock drilling equipment.

B. Wet down the muck pile after blasting to control dust during mucking operations.

C. Equipment for on-site and off-site particle velocity and air overpressure monitoring shall be 4-channel (one overpressure and three seismic channels) units capable of digitally storing collected data. Equipment must be capable of printing ground motion time histories and summaries of peak motion intensities, frequencies and USBM RI8507 PPV frequency plots. Printed report records must also include date, time of recording, operator name, instrument number and date of last calibration.

1. Instruments shall have a flat frequency response between 2 and 250 Hz for particle velocity and from 2 to 200 Hz for air-overpressure.

2. The digitizing sampling rate for peak particle velocity and air overpressure measurements shall be at least 1,024 samples per second.

3. Seismographs shall be capable of performing a self-test of velocity transducers and printed event records shall indicate whether or not the sensor test was successful.

4. Seismographs used for off-site compliance monitoring shall be capable of recording overpressure from 100 to 148 dB-L, and particle velocity from 0.05 to 5.0 inches/second.

5. Systems shall be capable of providing printed event reports that include all peak measurements, frequencies and complete waveform plots.

6. Seismographs shall have adequate memory to digitally record the entire duration of the blast-induced motion.

7. All seismograph/software systems shall be capable of saving back-up copies of all event files.

8. If the frequency of blast-induced ground motion for close-in blasting is expected to exceed 250 Hz, monitoring shall be done with instruments that measure acceleration with intensities up to 10 gs and at frequencies between 200 and 5,000 Hz.

D. The **Contractor** shall supply the **Owner** with four blast monitoring units as described in Article 2.02, Paragraph A, for the duration of the blasting and for each area of the project where blasting is taking place. The **Contractor** shall provide for annual calibration for each of the blast monitoring units and any repair or maintenance required.

2.03 CONDITION SURVEY

A. Prior to the commencement of any underground operations or surface blasting operation, a pre-construction survey shall be conducted following Section 01051.

PART 3 – EXECUTION

3.01 GENERAL

A. Firing shall be permitted only after the proper precautions have been taken for the protection of all persons, work, and property.

B. Blasting shall be limited to the hours of 7:00 a.m. to 7:00 p.m., Monday through Friday. Blasting is not allowed on Weekends or Holidays.

C. The **Owner** shall be notified 24 hours before blasts occur at any specific location. The **Contractor** shall provide the **Engineer** with a schedule for all blasts and shall notify the **Engineer** if any blast is delayed for more than one

hour. However, the **Contractor** will be allowed to re-shoot missed holes and tights, as they are uncovered without advance notice to the **Engineer.**

D. Acceptable Controlled Blasting methods will be those utilizing smooth wall blasting, cushion blasting, and line drilling techniques. Use of "pre-splitting" in shafts and surface excavations is specifically prohibited. Maximum drill round lengths, including subdrilling shall not exceed 0.75 times the minimum dimension of the tunnel or shaft opening. The first eight feet of any tunnel or shaft excavation shall utilize rounds that do not exceed four feet in length. The 4-foot round length restriction does not include subdrilling which shall not exceed 6 inches.

E. Holes shall not be charged with explosives at the same time that drilling or other mechanized equipment not needed to charge the round is being operated within 50 feet of the blast area.

F. The first blasting operation shall be conducted by the **Contractor** as a test case. The first test blasts shall be no larger than 25 percent of the planned production design blast sized as measured by charge-weight-per-delay. The second and third test blasts shall be no larger than 60 and 100 percent respectively of the planned production design blast. Alternate test blasting plans may be proposed by **Contractor** with approval of **Engineer.** After each test blast and review of test blasting data, the **Contractor** and **Engineer** shall meet to review the program. Modifications to the blasting program may be required as a result of this review. Drilling and delay patterns, amount and type of explosive to be used in subsequent production blasts shall be revised according to the results of the test case.

G. Monitoring and recording of air-overpressure and vibration will be performed by the **Engineer** for every blast round. The results will be provided to the Contractor within 24 hours of the blast, for review. Changes in drilling and delay patterns and amount of explosives shall be made when tests indicate vibrations and/or overpressures in excess of that specified herein. Any major changes in the production blast design shall be submitted to the **Engineer**.

H. All blasts in shaft and open cut excavations shall be covered with a sufficient number of steel cable mats or other substantial covering device in order to prevent injury to persons and property, including the structure and equipment used in connection with shaft or tunnel operation, from flying rock or other material.

I. When blasting underground, the **Contractor** shall ventilate the shaft and tunnel prior to personnel entering. After a blast is fired, all loose and shattered rock or other loose material, which may endanger the structure or the workers shall be removed and the excavation made safe before proceeding with work. Before drilling of blast holes for a new round, the face

shall be thoroughly cleaned and examined for missed holes and unexploded charges. Blasting techniques shall be developed and improved as work progresses. The fact that the removal of loose or shattered rock or other loose material may enlarge the excavation beyond the required limits shall not relieve the **Contractor** of responsibility for such removal and subsequent additional backfill or concrete, and the Contractor shall not be entitled to additional payment for overexcavation or overbreak.

J. All transportation of explosives on the surface or underground and any handling, blast charging or tie-in operations shall be stopped immediately upon the approach of an electrical storm, and all persons shall immediately be evacuated from the blasting area to a place of safety. In shafts, tunnels or other excavation handing explosives, loading of holes, connecting up or firing of charges shall not be performed during an electrical storm and all persons shall withdraw to a safe distance from a partially or totally loaded face. During such storms, explosives on the surface shall be left in OSHA-approved transport containers, delivery vehicles, day-storage boxes or in approved storage magazines. At all times, explosives shall be watch-guarded and secured by the **Contractor**'s personnel that are in safe locations.

K. All light and power circuits shall be disconnected and/or removed to a point not less than 100 feet from the face while explosives are being transported into the area and while the loading operations are taking place. During the loading operations only OSHA approved lighting may be used.

3.02 WARNING SYSTEM

A. The **Contractor** shall erect signboards of adequate size stating that blasting operations are taking place in the area, and such signs shall be clearly visible at all points of access to the area. These signs shall also clearly display the audible warning signals (horn signals) that will be used to warn all people in the area of the impending blast.

B. An audible blast warning system shall be established, publicized, and operated only during blasting hours.

C. The **Contractor** shall operate a system to ensure that blasting operations shall not be undertaken until it can be demonstrated that all personnel are accounted for and in a safe location.

3.03 BLASTING LIMITATIONS

A. The following limits on peak particle velocities and air blast overpressure, or such lower limits as established by the **Contractor's** Blasting Vibration Consultant, shall apply:

1. At structures and utilities in the vicinity of blasting operations, the peak particle velocity resulting from blasting shall not exceed:

    a. Frequency < 3 Hz: 0.2 inches/second.

    b. Frequency 3 - 10 Hz: 0.5 inches/second.

    c. Frequency 10 - 40 Hz: varying linearly 0.5 to 1.0 inches/second.

    d. Frequency > 40 Hz: 1.0 inches/second

    The above limits are adopted from modified blasting level criteria given in U.S. Bureau of Mines Recommendations RI-8507.

2. In the permanent concrete work, the peak particle velocities resulting from blasting shall not exceed two (2) inches per second.

3. At the nearest structure subject to damage from air blast overpressure, the mean peak air blast overpressure shall not exceed 0.01 psi. Measure readings for peak particle velocity in three (3) orthogonal directions by equipment approved by the **Owner** that is either continually recording or triggered by a preset level of vibration. Determine particle velocity in each frequency range by spectral analysis. Zero crossing method to determine frequency is not acceptable.

B. Air- overpressure shall not exceed 130 decibels when monitored with an instrument with a 2-hertz high pass at any occupied structure. Air overpressure monitoring shall take place at the nearest residential or business structures susceptible to damage or claims of annoyance.

C. All measurements of blast-induced air-overpressure shall be done in accordance with the standards developed by the Vibration Section of the International Society of Explosives Engineers-1999.

D. No blasting is allowed within 40 feet of freshly placed concrete or grouted rock until 12 hours has elapsed since placement.

E. Blasting within fifty (50) feet of permanent concrete work may be permitted only after approval of the **Contractor**'s plans showing the relative positions of the concrete, the area to be blasted, and the blasting technique to be employed. All concrete work shall be protected by limiting the size of blasts, covering blasts, and by other means until it is established that there is no danger of damage caused by either vibration or flying rock.

F. Exercise all possible care in drilling and blasting operations to ensure the stability of the remaining rock and to keep overbreak to a minimum. Written

controlled blasting techniques to be used shall be submitted to the **Owner** for approval.

G. Before the firing of any blast where flying material may result in damage to persons, property, or the work, cover the rock to be blasted with suitable matting and overburden to prevent flying debris. After a blast is fired, remove all loose and shattered rock or other loose material that may endanger the structure or the workers, and make the excavation safe before continuing with the work. Carry out similar checks on previously excavated sections at least every 48 hours and recheck the support system, tightening lagging, and blocking, and adding rock dowels, mesh and other support measures as required. Before drilling new blast holes, thoroughly clean the face and examine the face for holes containing undetonated explosives.

3.06 SUSPENSION OF BLASTING

A. Blasting operations may be suspended by the **Owner** for any of the following reasons:

1. The **Contractor**'s safety precautions are inadequate.

2. Air overpressure or ground motion levels exceed specified limits.

3. Existing structural conditions on and off site are aggravated and are damaged by blasting.

4. Blasting causes instability of slopes or causes damage to rock outside the prescribed limits of excavation.

5. The results of the blasting, in the opinion of the **Owner**, are not satisfactory.

6. Failure of the **Contactor** to adhere to the submitted and accepted blast plan.

B. In the event that damage occurs due to blasting work, suspend all blasting immediately and make a report to the **Owner**. Blasting operations shall not resume until the **Owner** has approved the **Contractor**'s revised blasting plan with modifications correcting the conditions causing the suspension.

3.07 BLASTING RECORDS

A. **Contractor** shall maintain a record of each blast detonated. Document the following records and information for each blast performed:

1. Depth of blast holes and the location of the blast point in relation to Project stationing.

2. Type, strength, and quantities of all explosives, types and quantities of detonators, powder factor (lbs/cy), and actual firing times of al charges.

3. Total explosive loadings per round and maximum charge per delay.

4. Type of rock blasted.

5. Reference to approved blast design submittal noting any modification.

6. Time spent scaling rock and approval of rock scaling by designated individual.

7. On a diagram of the approved blast pattern indicate any holes not drilled, drilled but not loaded, changes in spacing or in pattern of delay charges or in loading of holes. Include notes explaining why changes were made.

8. Submit an evaluation of the blast indicating tights, areas of significant overbreak and any recommended adjustments for future blasts.

9. Comments by the blaster in charge regarding any misfires, unusual results, or unusual effects.

10. Date and exact firing time of blast; name of person in responsible charge of loading and firing and blaster permit number.

11. Signature and title of person making recording entries.

12. Record of peak overpressure: Two copies of all blast vibration monitoring data obtained independent of monitoring performed by the **Engineer**. Submit hard copies of 4-channel waveforms for each blast.

13. Any other records required by federal, state and local codes, laws, regulations and ordinances.

3.08 PRE-BLAST/POST-BLAST INSPECTIONS

A. Pre-blast and post-blast inspections shall be performed in conformance with **Section 01714 - Pre-Construction & Post-Construction Inspections and Surveys**.

B. If blasting causes excessive overbreak or excessive fracturing of the surrounding rock, or is otherwise detrimental to the work, modify the blast design as necessary to achieve the desired result, and resubmit it to the **Owner**.

3.09 DAMAGE REPAIR

A. When blasting operations damage off-site properties or a portion of the work or material surrounding or supporting the work, promptly repair or replace damaged items to the condition that existed prior to the damage, to the satisfaction of the **Owner**.

+++ END OF SECTION 02405 +++

SECTION 02485
SEEDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. 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. In general, seeding operations shall be conducted on all newly graded earthen areas not covered by structures, pavement, or sidewalks; all cleared or grubbed areas that are to remain as finish grade surfaces; and on all existing turf areas that 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.

B. The work shall 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 on any disturbed area left exposed for a period greater than seven (7) days.

C. Areas disturbed by construction activities, shall be restored to their original conditions with regard to surface grading, drainage, grass type (predominate), or other landscape features.

1.02 RELATED WORK

A. Section 02000 – Site Work

B. Section 02125 - Temporary and Permanent Erosion and Sediment Control

C. Section 02486 – Sodding

D. Erosion and Sediment Control Plan

1.03 QUALITY ASSURANCE

A. Prior to seeding operations, the **Contractor** shall furnish to the **Owner** all 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.

B. 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.

1.04 ALTERNATE METHODS

A. The **Contractor** may propose alternate means and methods to establish a satisfactory coverage of healthy grass of the type required. The **Contractor** shall submit sufficient information to enable the **Owner** to assess the acceptability of the alternate approach.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. The **Contractor** shall place a minimum of 4 inches of topsoil over all graded earthen areas and over any other areas to be seeded. The quality of topsoil shall be acceptable to the **Owner**.

B. 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 ½ 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 perennial weed seeds, and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life.

C. 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 five and five tenths to seven (5.5 to 7.0). Topsoil shall contain not less than five (5) percent or more than twenty (20) percent, by weight, of organic matter as determined by loss on ignition of oven-dried samples to sixty-five (65°C0 degrees centigrade.

2.02 SEED

A. 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.

B. 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.

C. Seed shall bear the growers analysis testing to ninety eight (98) percent for purity and ninety (90) percent for germination. At the discretion of the **Owner**, samples of seed may be taken for check against the grower's analysis.

D. Species, rate of seeding, fertilization, and other requirements shall be as necessary to successfully establish the required stand of grass.

2.03 FERTILIZER AND LIMING MATERIALS

A. Fertilizer and liming materials shall comply with applicable state, local, and federal laws concerned with their production and use.

B. Commercial fertilizer shall be a ready mixed material of grade 18-46-0. Container bags shall have the name and address of the manufacturer, the brand name, net weight, and chemical composition.

C. Agricultural limestone shall be a pulverized limestone having a calcium carbonate content of not less than 85 percent by weight. Agricultural limestone shall be crushed so that at least 85 percent of the material shall pass a No. 10 mesh screen and 50 percent shall pass a No. 40 mesh screen.

2.04 MULCH MATERIAL

A. All mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.

B. 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.

C. Wood-cellulose fiber mulch shall be as manufactured by Weyerhaeuser Company, Conway Corporation, or equal.

D. Straw mulch shall be partially decomposed stalks of wheat, rye, oats, or other approved grain crops.

E. Stalks shall be the partially decomposed, shredded residue of corn, cane, sorghum, or other approved standing field crops.

2.05 MULCH BINDER

A. Mulch on slopes exceeding three to one (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.

B. Emulsified asphalt binder shall be Grade SS-1, ASTM D 977. Cutback asphalt binder shall be Grade RC 70 or RC 250.

2.06 INOCULANTS FOR LEGUMES

A. 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.

2.07 WATER

A. Water shall be clean, clear water free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the **Contractor**.

PART 3 - EXECUTION

3.01 PLACING TOPSOIL

A. Before placing or depositing topsoil upon any areas, all improvement within the area shall be completed.

B. The areas in which topsoil is to be placed or incorporated shall be prepared before securing topsoil for use.

C. Wetland and stream buffer locations to be topped with native soil stored upland on the project site.

3.02 SEEDBED PREPARATION

A. Before fertilizing and seeding, all topsoil surfaces shall be trimmed and worked to true line free from unsightly variation, bumps, ridges and depressions, and all detrimental material, and roots. All stones larger than two (2) inches in any dimension shall be removed from the soil. All non-residential and residential areas shall be hand raked to remove all detrimental material, roots, and stones

B. No earlier than twenty-four (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 two (2) inches with a weighted disc, tiller, pulvimixer, or other equipment, until the surface is smooth.

C. If the prepared surface becomes eroded because of rain or for any other reason, or becomes crusted before the seed is sown, the surface shall again be placed in a condition suitable for seeding.

D. Ground preparation operations shall be performed only when the ground is in a tillable and workable condition.

3.03 FERTILIZATION AND LIMING

A. Following seedbed preparation, fertilizer shall be applied to all areas to be seeded so as to achieve an application rate 80 pounds per acre.

B. Fertilizer shall be spread evenly over the seedbed and shall be lightly harrowed, raked, or otherwise incorporated into the soil for a depth of ½ inch.

C. 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 thirty (30) minutes when a hydraulic seeder is used.

D. Agricultural limestone shall be thoroughly mixed into the soil at a rate of one to two (1 to 2) tons per acre. The specified rate of application of limestone may be reduced by the **Owner** 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 **Owner** for adjustment in rates.

E. It is the responsibility of the **Contractor** to make one application of maintenance fertilizer at one-half the original rates applied in early spring following initial establishment of cover.

3.04 SEEDING

A. 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 periods shown below. Seed mixtures may be sown together provided they are kept in a thoroughly mixed condition during the seeding operation.

B. Seeds shall be uniformly sown by any approved mechanical method to suit 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. Hydroseeding and hydromulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder so that the seeding's are at the proper rate before seeding operations are started, and to maintain their adjustment during seeding. Seed in hoppers shall be agitated to present segregation of the various seeds in a seeding mixture.

C. Immediately after sowing, the seeds shall be covered and compacted to a depth of one-eighth to three-eighths (1/8 to 3/8) inch by a cultipacker or suitable roller.

D. Leguminous seeds shall be inoculated prior to seeding with an approved and compatible nitrogen-fixing inoculant in accordance with the manufacturer's mixing instructions.

E. Stream buffer shall be seeded with native riparian grass mix; Roundstone Seed Mix 168 or similar, applied at 10 lbs. per acre or from the Buffer Seeding Requirements Table.

Seeding Requirements Table

The seed shall be a mixture as shown in the Table below, and shall be applied at the following rates shown:

Seeding Requirements		
Season	**Type of Seed**	**Pounds Per Acre**
Jan 1 – May 15	Unhulled Common Bermuda	45
	Kentucky 31 Fescue	300
	Rebel II Supreme	150
May 16 – Sept 1	Hulled Common Bermuda	75
Sept 2 – Dec 31	Unhulled Common Bermuda	45
	Kentucky 31 Fescue	300
	Rebel II Supreme	150
Buffer Seeding Requirements		
Season	**Type of Seed**	**Pounds Per Acre**
Jan 1 – May 15	Switch Grass	40
	Virginia Wild Rye	20
	Big Blue Stem	12
May 16 – Sept 1	Riparian Seed Mix	10
Sept 2 – Dec 31	Fall Panicum*	1
	Deer Tongue Grass*	3

* Required to be mixed - riparian mitigation seed mix combinations to be applied at a minimum rate of 10 lbs per acre for each combined mix.

3.05 MULCHING

A. All areas to be seeded shall be uniformly mulched in a continuous blanket immediately after seeding when using Wheat straw at a minimum of two and one-half (2½) tons per acre or equivalent to two to four (2" to 4") inches thickness. The rate of application shall correspond to a depth of at least one inch and not more than one and one half inches, according to the texture and moisture content of the mulch material. It is intended that mulch shall allow some sunlight to penetrate and air to circulate, at the same time shading the ground, reducing erosion and conserving soil moisture. The **Contractor** shall take steps necessary to prevent loss of mulch or bunching of mulch as caused by the wind.

B. Mulch on slopes greater than three to one (3 to 1) ratio shall be held in place by the use of an approved mulch binder. Binder shall be thoroughly mixed and applied with the mulch. Emulsified asphalt or cutback asphalt shall be applied at the approximate rate of five (5) gallons per one thousand (1,000) square feet as required to hold the mulch in place.

C. 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.

D. Mulch and binder shall be applied by suitable blowing equipment at closely controlled application rates.

3.06 WATERING

A. **Contractor** shall be responsible for maintaining the proper moisture content of the soil to ensure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain adequate water content in the soil. Water shall not be applied when there is danger of freezing. In the event that official watering bans or water restrictions are in effect, the Contract shall comply with applicable guidelines on watering for new grassing.

B. Watering shall be accomplished by hoses, tank truck, or sprinklers in such a way to prevent erosion, excessive runoff, and overwatered spots.

3.07 MAINTENANCE

A. 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.

B. The **Contractor** shall maintain all seeded area without additional payment until final acceptance of the work by the **Owner**, including all regrading, refertilizing, reliming, reseeding, remulching, and watering required. Seeding work shall be repeated on defective areas until the **Owner** is satisfied that a satisfactory uniform stand is accomplished Damage resulting from erosion, gulleys, washouts, or other causes shall be repaired at the **Contractor**'s expense by filling with topsoil, compacting, and repeating the seeding work.

3.08 VEGETATIVE STABILIZATION SCHEDULE

A. The **Contractor** shall stabilize disturbed areas as construction progresses. The time duration limitations for stabilization of disturbed areas by either temporary mulching (for 7 days or less), temporary grassing, permanent grassing, or permanent sodding shall be as specified in **Section 02125 - Temporary and Permanent Erosion and Sediment Control**; however, unstabilized areas of the construction corridor shall not exceed one thousand (1,000) linear feet on sanitary sewer sewers or water mains installed with easements and three hundred (300) linear feet for all other projects. Stabilization with permanent vegetation is preferred unless seasonal limitations exist.

+++ END OF SECTION 02485 +++

SECTION 02486
SODDING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Sodding shall consist of establishing certain critical areas with sod as designated on the drawings.

B. Areas disturbed by construction activities shall be restored to their original conditions with regard to surface grading, drainage, grass type (predominate), or other landscape features.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02000 - Site Work

B. Section 02125 - Temporary and Permanent Erosion and Sediment Control

C. Section 02485 - Seeding

D. Erosion and Sediment Control Plan

1.03 ALTERNATE METHODS

A. The **Contractor** may propose alternate means and methods to establish a satisfactory coverage of healthy grass of the type required. The **Contractor** shall submit sufficient information to enable the **Owner** to assess the acceptability of the alternate approach.

PART 2 - PRODUCTS

2.01 SOD

A. Sod shall consist of a live, dense, well-rooted growth of turf grass species as noted on the Drawings. The sod shall be free from Johnson grass, nut grass and other obnoxious grasses, of suitable character for the purpose intended and for the soil in which it is to be planted. It shall be uninjured at the time of planting.

B. Sod shall be uniform in thickness, having not over two (2) inches or less than one (1) inch of soil.

C. Sod strips shall have a consistent width of twelve or eighteen (12 or 18) inches.

2.02 FERTILIZER

A. Fertilizer (10-10-10) used in connection with sodding, shall contain ten (10) percent nitrogen, ten (10) percent phosphoric acid and ten (10) percent potash. The fertilizer shall be furnished in standard containers with the name, weight, and guaranteed analysis of the contents clearly marked. The containers shall ensure proper protection in handling and transporting the fertilizer. All commercial fertilizer shall comply with local, state, and federal fertilizer laws.

B. Ammonium nitrate shall be a standard commercial product, shall conform to the requirements for other commercial fertilizers as specified above, and shall have a minimum of thirty-three and one-half (33½) percent nitrogen.

2.03 LIME

A. Agricultural limestone shall contain not less than eighty-five (85) percent of calcium carbonate and magnesium carbonate combined and shall be crushed so that at least eighty-five (85) percent shall pass the No. 10 mesh sieve and fifty (50) percent shall pass a No. 40 mesh screen.

2.04 WEATHER LIMITATIONS

A. Sod shall be placed only when the soil is moist and favorable to growth. No placement shall occur unless weather and soil conditions are considered favorable for the successful establishment of the particular sod type being placed.

PART 3 - EXECUTION

3.01 SODDING

A. The area to be sodded shall be constructed to the lines and grades indicated on the Drawings and the surface loosened to a depth of not less than three (3) inches with a rake or other device. As applicable, clean, uniform topsoil shall be placed to provide a rich bed for root growth. If necessary, the area shall be sprinkled until saturated at least one (1) inch in depth and kept moist until the sod is placed thereon. Immediately before placing the sod, the fertilizer shall be uniformly applied at the rate of twenty-five (25) pounds of Grade 10-10-10, or equivalent, per one thousand (1,000) square feet. Agricultural limestone shall be applied at the rate of one hundred (100) pounds per one thousand (1,000) square feet.

B. The entire area shall be thoroughly covered with sod. Sod shall be placed on the prepared surface with edges in close contact and, as far as possible, in a position to break joints.

C. Sod shall be maintained moist from time of removal until reset but shall be placed as soon as practicable after removal from place where growing. Immediately after placing, it shall be rolled with a roller or hand tamped to the satisfaction of the **Owner**.

D. Sod on slopes steeper than three to one (3 to 1) shall be held in place by wooden pins about one (1) inch square and six (6) inches long, driven through the sod into the soil until they are flush with the top of the sod.

3.02 WATERING AND MAINTENANCE

A. Sod shall be watered for a period of two (2) weeks after which ammonium nitrate shall be applied at the rate of three (3) pounds per one thousand (1,000) square feet and the sod given a final watering. Water shall not be applied when there is danger of freezing. In the event that official watering bans or water restrictions are in effect, the **Contractor** shall comply with applicable guidelines on watering for new grassing.

B. The **Contractor** shall not allow any equipment or material to be placed on any planted area and shall erect suitable barricades and guards to prevent his equipment, workers, or the general public from traveling over any area planted with sod.

C. It shall be the obligation of the **Contractor** to secure a satisfactory growth of grass before final acceptance of the project by the **Owner**

3.03 VEGETATIVE STABLIZATION SCHEDULE

A. The **Contractor** shall stabilize disturbed areas as construction progresses. The time duration limitations for stabilization of disturbed areas by either temporary mulching for seven (7) days or less, temporary grassing, permanent grassing or permanent sodding shall be as specified in **Section 02125 - Temporary and Permanent Erosion and Sediment Control**; however, unstabilized areas of the construction corridor shall not exceed one thousand (1,000) linear feet on sanitary sewer sewers or water mains installed within easements and three hundred (300) linear feet for all other projects. The permanent vegetative stabilization method is preferred unless seasonal limitations exist.

+++ END OF SECTION 02486 +++

SECTION 02510
ASPHALT PAVING

PART 1 - GENERAL

1.01 SCOPE:

A. The work under this Section includes, but it is not necessarily limited to, the furnishing and installation of all asphalt paving materials and pavement base materials as indicated on the Drawings and as necessary for the proper performance of this work.

B. Related Work Specified Elsewhere:

Section 02200 - Earthwork.

1.02 SUBMITTALS

A. 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. Batch design.

2. Density and viscosity tests on each run.

3. Weight slips for pavement base and asphalt paving materials.

1.03 QUALITY ASSURANCE:

A. Unless otherwise indicated on the Drawings or herein specified, all work under this Section shall be performed in accordance with the current Georgia Department of Transportation Standard Specifications.

B. Furnish weight slips for all material incorporated in the Project to verify that the required tonnage has been applied.

1.04 PRODUCT HANDLING:

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to gain the approval of the **Engineer** at no additional cost to the **Owner**.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General: All materials and products for the work under this Section shall conform to the current Georgia Department of Transportation Standard Specifications except as otherwise specified herein.

B. Graded Aggregate Base: The sub-base 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% Standard Proctor Density. (ASTM D-698)

C. 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".

D. Surface Course: The surface course for all pavement, including paint or tack coat when required by the **Enginee**r, shall conform to the requirements of the Georgia Department of Transportation Specifications for Asphaltic Concrete, Section 828, Type "E".

E. Prime coat shall be in accordance with Section 412 of the DOT Standard Specifications.

F. Tack coat shall conform to Section 413 of the DOT Standard Specifications.

PART 3 - EXECUTION

3.01 EXCAVATING. FILLING AND GRADING:

Perform excavating and filling in accordance with Section 02200 entitled "Earthwork" of these Specifications.

3.02 INSTALLATION:

A. Asphaltic construction shall be performed in accordance with Section 400 of the Georgia Department of Transportation "Standard Specifications, Construction of Roads and Bridges".

B. Place each course in the required quantities so that when compacted, they will conform to the indicated grade, cross section and minimum thickness as specified or as indicated in the Drawings.

3.03 CLEANING:

A. Prior to acceptance of the work of this Section, clean the pavement and related areas in accordance with the requirements of the General Conditions of the Contract Documents.

+++ END OF SECTION 02510 +++

SECTION 02521
CONCRETE SIDEWALKS, CURBS AND GUTTERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for construction of concrete sidewalks, concrete monolithic sidewalk and curb, concrete header curb, concrete curb, concrete gutter and concrete combined curb and gutter, which shall consist of monolithic curb and gutter respectively, all constructed of Portland cement concrete, at the locations, and to the lines, grades, cross section, form and dimensions indicated on the Drawings.

B. Cement concrete sidewalks, concrete monolithic sidewalk and gutter, concrete header curb, concrete curb, concrete curb, gutter and combined curb and gutter shall include all necessary excavation, unless otherwise indicated, and subgrade preparation; backfilling, and final clearing up; and completion of all incidentals thereto, as indicated on the Drawings or as directed by the **Engineer**.

C. Related Work Specified Elsewhere:

1. Section 02110 - Clearing and Grubbing.

2. Section 02200 - Earthwork.

3. Section 02510 - Asphalt Paving.

4. Section 03200 - Concrete Reinforcement

5. Section 03300 - Cast-In-Place Concrete.

1.02 PRODUCT HANDLING

A. Protection: Use all means necessary to protect concrete materials before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the satisfaction of and approval of the **Engineer** at no additional cost to the **Owner**.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 CONCRETE REINFORCEMENT

A. Concrete reinforcement shall conform to Section **03200 - Concrete Reinforcement and Dowelling**.

2.02 CONCRETE AND RELATED MATERIALS

A. General: Concrete and related materials including, but not necessarily limited to, joint materials, membranes and curing compounds shall conform to **Section 03300 - Cast-In-Place Concrete.**

B. Class: All concrete for all non-structural flatwork shall be Class B 4,000 psi and conform to requirements of **Section 03300**. Concrete for Pump Stations, Wet-wells, and Pump station pads should be as specified in the Owner Standards

C. Water used in mixing concrete shall be fresh, clean, potable water free from injurious amounts of oil, acid, alkali, vegetable, wastewater and/or organic matter.

D. Admixtures shall meet the following requirements:

1. Except as herein specified, no curative or hardening admixtures shall be used.

2. An air entrainment agent capable of providing 3 to 6 percent air shall be used. Air entraining admixtures which are added to concrete mixtures shall conform to ASTM C 260 for Air Entraining Admixtures for Concrete.

F. Sub-base shall be constructed of durable material such as bank-run gravel. Minimum depth of sub-base shall be 3-inches.

G. Joint filler shall be a non-extruding joint material conforming to AASHTO M21 3 for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (non-extruding and resilient bituminous types). The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise specified by the **Engineer**.

PART 3 - EXECUTION

3.01 EARTHWORK

A. General: All earthwork shall be performed in accordance with **Section 02200 - Earthwork**, and as specified in this Section.

B. Backfilling

1. After the subgrade for sidewalks is compacted and at the proper grade, spread 3 inches or more of sub-base material. Sprinkle with water and compact by rolling or other approved method. Top of the compacted gravel shall be at the proper level to receive the concrete.

2. After the concrete has set sufficiently, the spaces on both sides of the curb, gutter, and combined curb and gutter shall be backfilled, and the materials compacted and left in a neat and workmanlike condition.

3. Curbs to be used in the construction of asphalt pavements shall be backfilled prior to placement of base material for asphalt pavement.

3.02 SUBGRADE PREPARATION

A. The subgrade shall be formed by excavating to the required depth below the finished surface of the respective types, in accordance with the dimensions and designs indicated on the Drawings or as directed by the **Engineer** and shall be of such width as to permit the proper installation and bracing of forms. The subgrade shall be compacted by hand tamping and all soft, yielding or unsuitable material shall be removed and backfilled with satisfactory material and again compacted thoroughly to minimum of ninety-five percent (95%) of the modified proctor maximum dry density as determined by ASTM D1557.. The finished grade shall be to the dimensions and design indicated on the Drawings or as directed by the **Engineer** for the bottom of the proposed construction.

3.03 CONCRETE CURB AND GUTTER CONSTRUCTION

A. Construct curbs to lines and grade shown or established by the **Engineer**. Curbs shall conform to the details shown on the Drawings.

B. Forming:

1. Forms shall be metal and of an approved section. They shall be straight, free from distortions, and shall show no vertical variation greater than 1/4-inch in 10 feet, and shall show no lateral variation greater than ¼-inch in 10 feet from the true plane surface on the vertical face of the form.

2. Forms shall be of the full depth of the structure and be so constructed as to permit the inside forms to be securely fastened to the outside forms.

3. Securely hold forms in place true to the lines and grades indicated on the Drawings.

4. Wood forms may be used on sharp turns and for special sections as approved by the **Engineer**.

5. Where wooden forms are used, they shall be free from warp and the nominal depth of the structure.

6. All mortar and dirt shall be removed from forms and all forms shall be thoroughly oiled or wetted before any concrete is deposited.

7. The supply of forms shall be sufficient to permit their remaining in place at least 12 hours after the concrete has been placed.

C. Joints:

1. Joints shall be constructed as indicated on the Drawings and as specified.

2. Construct joints true to line with their faces perpendicular to the surface of the structure and within ¼-inch of their designated position.

3. Thoroughly spade and compact the concrete at the faces of all joints to fill all voids.

4. Install expansion joint materials at the point of curve at all street returns.

5. Install expansion joint material behind the curb at abutment to sidewalks and adjacent structures.

6. Place contraction joints every 10 feet along the length of the curbs and gutters.

7. 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.

8. Contraction joint templates or plates shall not extend below the top of the steel reinforcement or shall be notched to permit the reinforcement to be

continuous through the joint.

9. Contraction joints shall be a minimum of 1-1/2-inches deep.

D. Finishing:

1. 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.

2. Finish the face of the curbs at the top and bottom with an approved finishing tool of the radius indicated on the Drawings.

3. Finish edges with an approved finishing tool having a 1/4-inch radius.

4. Provide a final broom finish by lightly combing with a stiff broom after troweling is complete.

5. The finished surface shall not vary more than 1/8-inch in 10 feet from the established grade.

E. Concrete Curing:

1. After finishing operations have been completed and immediately after the free water has left the surface, the surface of the structure shall be completely coated and sealed with a uniform layer of curing compound specified in **Section 03300 - Cast-In-Place Concrete**.

2. The compound shall be applied in one or two applications as directed by the **Engineer**. When the compound is applied in two (2) increments, the second application shall follow the first application within 30 minutes.

3. The compound shall be applied continuously by means of an automatic self-propelled, pressure sprayer as approved by the **Engineer** at the rate directed by the **Engineer**, but not less than 1 gallon per 200 square feet of surface.

4. The equipment shall provide adequate stirring of the compound during application.

5. Should the method of applying the compound not produce uniform coverage, its use shall be discontinued, and the curing shall be by

another method approved by the **Engineer**.

F. Protection:

1. Provide and use sufficient coverings for the protection of the concrete in case of rain or breakdown of curing equipment.

2. Provide necessary barricades and lights to protect the work and rebuild or repair to the approval of the **Engineer**. 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 **Owner**.

3.04 SIDEWALK CONSTRUCTION

A. Sidewalks shall be 4 inches thick.

B. At locations where the new sidewalk is to abut existing concrete, sawcut concrete for a depth of 2 inches and chip the old concrete back to sound material on a straight line, clean the surface, and apply a neat cement paste just prior to pouring the new sidewalk.

C. Joint:

1. Place preformed asphalt expansion joints as in the adjacent curb, where the sidewalk ends at the curb, and around posts, poles, or other objects protruding through the sidewalk.

2. Provide contraction joints transversely to the walks at locations opposite the construction joints in the curb. These joints shall be straight and at right angles to the surface of the walk.

D. Finishing:

1. Broom the surface with a fine-hair broom at right angles to the length of the walk and tool all edges, joints, and markings. Mark the walks transversely with a jointing tool.

E. Concrete Curing

1. After the finishing operations have been completed and immediately after the free water has left the surface, the surface of the structure shall be completely coated and sealed with a uniform layer of curing compound specified in **Section 03300, Cast-In-Place-Concrete**.

2. The compound shall be applied in one or two applications as directed by the **Engineer**. When the compound is applied in two (2) increments, the second application shall follow the first application within 30 minutes.

3. The compound shall be applied continuously by means of an automatic self-propelled pressure sprayer as approved by the **Engineer** at the rate directed by the **Engineer**, but not less than 1 gallon per 200 square feet of surface.

4. The equipment shall provide adequate stirring of the compound during application.

5. Should the method of applying the compound not produce uniform coverage, its use shall be discontinued, and the curing shall be by another method approved by the **Engineer**.

F. Protection:

1. Protect the sidewalks from damage for a period of seven days.

2. All damage caused by people, vehicles, rain, animals and the **Contractor**, shall be repaired by the **Contractor** at no additional expense to the **Owner**.

3.05 REPLACEMENT CONCRETE CURB AND SIDEWALK

A. When a section is removed, the existing sidewalk or curb 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.

B. Existing concrete sidewalks and curbs 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 surfaces of the new work shall form an even, unbroken plane with the existing surfaces.

C. All work shall conform to the requirements for new sidewalks and curbs as detailed in this Section.

3.06 CLEANING

A. All excess or unsuitable material shall be disposed of as specified in **Section 02050 - Demolition.**

B. All surfaces of the Work and adjacent surfaces shall be broom clean. **Contractors** shall use pressure washing and other means approved by the **Engineer** to remove splashed and spilled concrete from the Work and adjacent surfaces.

C. Disturbed seeded areas shall be reseeded per requirements of **Section 02485 - Seeding**.

+++ END OF SECTION 02521 +++

SECTION 02534
HIGH DENSITY POLYETHYLENE PIPE

PART 1 GENERAL

1.01 SCOPE

A. The **Contractor** shall furnish all labor, materials, equipment and incidentals required to install and test all high density polyethylene pipe (HDPE) as shown on the Drawings and as specified herein.

B. This section covers high density polyethylene (HDPE) pipe ranging in sizes from 4-inches to 63-inches in diameter.

1.02 SUBMITTALS

A. 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. Product Data: The **Contractor** shall submit, for the **Engineer's** approval, descriptive details and shop drawings covering full details of pipe, fittings, specials, joints and the assembly thereof, joint materials and details thereof, and full details and cuts of all castings to be incorporated into the Work.

2. Manufacturer's Certificate: The **Contractor** shall submit a Manufacturer's Certificate certifying that products meet or exceed specified requirements.

1.03 QUALITY ASSURANCE

A. 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 Drawings or specified herein.

1. ANSI/AWWA C906 - Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4-in. Through 63-in. for Water Distribution and Transmission

2. ASTM D 2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR – PR) Based on Controlled Inside Diameter

3. ASTM D2657 – Standard practice for Heat Fusion Joining of Polyolefin Pipe and Fittings

4. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

5. ASTM D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR – PR) Based on Controlled Inside Diameter

6. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR – PR) Based on Outside Diameter

7. ASTM F1417 – Standard Practice for Installation Acceptance of Plastic Non pressure Sewer Lines Using Low Pressure Air

8. ASTM F2164 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure

9. ANSI/NSF 14/61 – Drinking Water System Components – Health Effects

B. (Not Used)

1.04 TRANSPORTATION AND HANDLING

A. 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.

B. Handling: Handle pipe, fittings and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift, or front loader. Do not use material damaged in handling.

1.05 STORAGE AND PROTECTION

A. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipes, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

C. Pipe shall be stored in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 GENERAL

A. HDPE materials and pipe shall be manufactured, inspected, sampled and tested in accordance with the requirements of ANSI/AWWA C906 and this section.

B. Sections of pipe with cuts, gouges or scratches on the outside pipe surface that exceed 5 percent of the wall thickness of the pipe shall be removed completely

and the pipeline rejoined. The inside diameter surface shall be free of cuts, gouges and scratches.

2.02 MATERIALS

A. HDPE piping components shall be manufactured from materials that conform to the requirements of ASTM D3350.

B. Bolts and nuts for buried mechanical joining of components such as flanges shall be made of non-corrosive, high strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any protective coating.

2.03 PIPE

A. Pipe shall have the nominal dimensions shown with an IPS outside diameter basis the dimensions and tolerances specified in ANSI/AWWA C906.

B. Pipe shall conform to the following:

Nominal outside diameter, inches	8
Dimension ratio (DR)	9
Pressure class in accordance with ANSI/AWWA C906	250

C. Pipe Identification

1. Pipe identification shall conform to the requirements of ANSI/AWWA C906.

2. Color identification shall be either striped by co-extruding longitudinal color markings or shall be solid color as follows:

   a. Blue – water

   b. Green – sanitary sewer

2.04 FITTINGS

A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the pipe manufacturer. **Contractor** fabricated fittings shall not be allowed.

B. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to complete the work as shown on the Drawings and as specified herein.

C. All fittings shall be installed using butt-fused fittings. No size-on-size wet taps shall be permitted.

D. All transitions from HDPE pipe to pipes of other materials shall be in accordance with the HDPE pipe manufacturer's recommendations and specifications. Solid sleeves shall not be allowed between material transitions.

PART 3 EXECUTION

3.01 INSTALLATION

A. General

1. HDPE may be installed by standard open trench excavation and backfill method as specified in **Section 02225 - Trench Excavation and Backfill**.

2. Prior to the installation of any pipe, a meeting shall be called by the **Contractor**, to include the **Contractor**, the pipe manufacturer, and the **Engineer** to review recommended procedures, to include pipe joining techniques and quality control.

3. Unless otherwise specified, pipe shall be installed in accordance with the manufacturer's instructions.

B. Joining

1. Sections of polyethylene pipe shall be joined into continuous lengths on the job site above ground. Unless otherwise specified, joining shall be by the butt-fusion method performed in accordance with the pipe manufacturer's recommendations and ASTM D2657. Socket fusion, extrusion welding and hot gas welding shall not be allowed. Butt-fusion joining shall be 100 percent efficient offering a joint strength equal to or greater than the tensile strength of the pipe.

2. Flanges, unions grooved couplers, transition fittings may be used to mechanically connect HDPE pipe without butt-fusion only when approved by the **Engineer**. Mechanical connections shall be as recommended by the pipe manufacturer.

3. The pipe supplier shall be consulted to obtain machinery and expertise for the joining by butt-fusion of HDPE pipe and fittings. No pipe or fittings shall be joined by fusion by any of the **Contractor's** personnel unless they are adequately trained and qualified in the fusion techniques involved. Butt-fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe.

3.02 CLEANING

A. At the conclusion of the work, the **Contractor** shall clean all pipe by flushing with water or other means to remove all dirt, stone wood or other materials which may have entered the pipe during construction.

B. (Not Used)

3.03 INSPECTION AND TESTING

A. Water Mains

1. All sections of pipelines shall be hydrostatically pressure tested in accordance with ASTM F2164 and these specifications. A section of the pipeline will be considered ready for testing after completion of backfilling.

2. Water used for flushing and testing pipelines and other construction purposes shall be furnished by the **Contractor**.

3. Each segment of pipeline between valves shall be tested individually.

4. Test Preparation

   a. For pipelines 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 pipelines 24-inches in diameter and larger, the pipe line shall be carefully swept clean, and mopped if directed by the **Engineer**. Partially open valves to allow the water to flush the valve seat.

   b. Provide temporary blocking, bulkheads, flanges and plugs as necessary, to assure all new pipe, valves and appurtenances will be pressure tested.

   c. Before applying test pressure, air shall be completely expelled from the pipeline and all appurtenances.

   d. Fill pipeline slowly with water. Provide a suitable pump with an accurate water meter to pump the line to the specified pressure.

   e. The differential pressure across a valve shall equal the maximum possible, but not exceed the rated working pressure. Where necessary, provide temporary backpressure to meet the differential pressure restrictions.

   f. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure.

5. Test Pressure: Test the pipeline at 150 psi measured at the lowest point for at least two hours.

6. 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.

7. The **Contractor** shall be responsible for legal disposal of all water used for flushing and testing.

B. Sewers

1. All sections of the pipeline shall be tested in accordance with ASTM F1417. A section of the pipeline will be considered ready for testing after completion of backfilling.

3.04 CLEANUP

A. After completing each section of the pipeline, 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 pipeline; 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.

B. (Not Used)

+ + + END OF SECTION 02534 + + +

SECTION 02535
GRAVITY FLOW SANITARY SEWERS

PART 1 - GENERAL

1.01 SCOPE

A. 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.

B. Unless directed otherwise in writing by the **Engineer**, the **Contractor** shall use only the pipe sizes and materials specifically designated on the Plans.

C. Related Work Specified Elsewhere:

1. Section 02060 - Crushed Stone Aggregate
2. Section 02200 - Earthwork
3. Section 02140 - Dewatering
4. Section 02537 - Ductile Iron Sanitary Sewer Pipe and Fittings
5. Section 02641 - Precast Concrete Manholes
6. Section 02650 - Testing for Acceptance of Sanitary Sewers
7. Section 02920 - Site Restoration
8. Section 03300 - Cast-In-Place Concrete

1.02 SUBMITTALS

A. 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. 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.

2. The **Contractor** shall submit manufacturers' instructions indicating special procedures required to install products specified.

3. The **Contractor** shall submit certifications that products meet or exceed the requirements specified in these Specifications.

4. The **Contractor** shall submit a set of plans (modified to show as-built conditions.)

5. The **Contractor** shall submit test reports.

1.03 QUALITY ASSURANCE

A. 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. 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.

2. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.

3. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

5. ASTM C700 – Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.

6. 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)

7. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

8. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

9. American Water Works Association (AWWA), Latest Revisions.

B. 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.

C. 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.

D. 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.

E. All pipe, accessories, and specials shall be new material.

F. 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 **Owner**. 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.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. The **Contractor** shall inspect pipe materials and fittings upon arrival at the site of the Work.

B. 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.

C. 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

2.01 PIPE MATERIALS

A. 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.

B. All materials shall be in strict compliance with the required standards and specifications including ASTM, ANSI, and AWWA.

C. 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.

D. Ductile Iron Pipe and fittings shall conform to the requirements of **Section 02537 - Ductile Iron Sanitary Sewer Pipe and Fittings**.

E. Reinforced Concrete Storm Drains shall conform to the requirements of **Section 02536 - Reinforced Concrete Storm Drain**.

F. Polyvinyl Chloride Gravity Sewer Pipe shall conform to the requirements **Section 02545 - Polyvinyl Chloride Gravity Sewer Pipe.**

2.02 APPURTENANCES

A. Manholes shall conform to the requirements of **Section 02641 - Precast Concrete Manholes.**

2.03 BACKFILL

A. Pipe backfill materials shall conform to the requirements of **Section 02324 - Trenching and Trench Backfilling**.

B. Topsoil shall conform to the requirements of **Section 02920 - Site Restoration**.

PART 3 - EXECUTION

3.01 GENERAL

A. 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.

B. 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.

C. 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.

D. The **Contractor** shall install and operate a dewatering system in accordance with the requirements of **Section 02140 - Dewatering**.

3.02 PIPE LAYING

A. The **Contractor** shall install the pipe in accordance with the pipe manufacturer's recommendations and as specified in this section.

B. 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.

C. 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**.

D. 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.

E. 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 any time more trench than its available pumping facilities are able to dewater. Movement of water that would tend to erode or affect the trench walls will not be allowed.

F. 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.

G. Backfilling of trenches shall be started immediately after the pipe is in place and the joints completed, inspected, and approved by the **Engineer**.

H. 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.

3.03 JOINT CONSTRUCTION

A. 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.

B. 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.

C. 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.

D. After the joints have been completed, they shall be inspected by the **Engineer** before they are covered. Any leaks or defects discovered at any time 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 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.

3.04 TEE CONNECTIONS

A. 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.

B. All existing sanitary service lines shall be disconnected from the existing combined sewer and reconnected to the new sanitary sewer.

C. 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**.

D. Tees shall be standard manufactured tees.

3.05 CONNECTING RISERS

A. 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.

B. 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 02234 – Trenching and Trench Backfilling** and compacted to the equivalent density of the surrounding undisturbed material.

3.06 TOLERANCES

A. 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 **Owner**.

2. If the sewer is laid at a grade less than that shown on the Plans, thus reducing the sewer's capacity, the **Owner** may require the sewer to be removed and relaid at the correct grade at no additional cost to the **Owner**. 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 Plans, 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 **Owner's** opinion, significantly reduces the sewer's capacity, the **Owner** may require the **Contractor** to remove and relay that portion of the sewer at the improper grade.

3.07 PIPE PROTECTION

A. 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**.

B. Plain concrete ditch checks may be required by the **Engineer** on steep slopes and other locations to prevent erosion of the backfilled trench.

3.08 TESTING

A. 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 Sewers**. Testing shall be performed in the presence of the **Engineer**.

B. **(**Not Used)

3.09 CLEANUP

A. 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 in accordance with requirements of **Section 02920 - Site Restoration**.

B. 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.

C. 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.

D. 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.

E. All manhole covers shall be brought to grade, as shown on the Plans, or as directed by the **Engineer**.

+++END OF SECTION 02535+++

SECTION 02536
REINFORCED CONCRETE STORM DRAIN PIPE

PART 1 GENERAL

1.01 SCOPE

A. The **Contractor** shall furnish all labor, materials, equipment and incidentals required to install all reinforced concrete storm drain pipe as shown on the Drawings and as specified herein.

B. (Not Used)

1.02 SUBMITTALS

A. 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. Product Data: The **Contractor** shall submit, for the **Engineer's** approval, descriptive details and shop drawings covering full details of pipe, fittings, specials, joints and the assembly thereof, joint materials and details thereof, and full details and cuts of all castings to be incorporated into the Work.

2. Manufacturer's Certificate: The **Contractor** shall submit a manufacturer's certificate certifying that products meet or exceed specified requirements.

B. Submit shop drawings to the **Engineer** for review showing a complete laying plan of all pipe, including all fittings, adapters, 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. The above shall be submitted to the **Engineer** for review before fabrication and shipment of these items.

1.03 QUALITY ASSURANCE

A. 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 Drawings or specified herein.

1. ASTM C33 – Specification for Concrete Aggregate

2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

3. ASTM C150 – Standard Specifications for Portland Cement

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes using Rubber gaskets.

5. ASTM C655 – Standard Specifications for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

6. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

7. ASTM C1619 – Standard Specification for Elastomeric Seals for Joining Concrete Structures

B. (Not Used)

1.04 TRANSPORTATION AND HANDLING

A. Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings, valves 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.

B. Handle pipe, fittings and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift or front loader. Do not use material damaged in handling.

1.05 STORAGE AND PROTECTION

A. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipes, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

C. Pipe shall be stored per the manufacturer’s recommendations.

D. Store joint gaskets 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.

1.06 ACCEPTANCE

A. Acceptance of pipe shall be on the basis of plant load-bearing tests of the pipe, material tests and inspection of manufactured pipe for visual defects and imperfections as described in paragraph 5.1.1 of ASTM C76.

B. All pipe shall be manufactured in accordance with the American Concrete Pipe Association QCast Storm Sewer quality assurance program. If pipe producer is not QCast certified, each length of pipe shall be stamped by a regular employee of an approved testing agency.

C. If producer is not QCast certified, provide results of tests on pipe, pipe materials, joint material and made-up joints by an independent testing laboratory approved by the **Engineer**. Include materials, absorption, crushing and hydrostatic leakage tests on pipe of each size in accordance with applicable specifications.

D. Inspect pipe after delivery for QCast or laboratory stamp, shape, cracks, uniformity, blisters and imperfect surfaces, hammer test, damaged ends and gasket grooves. Any pipe repaired or patched is subject to rejection if such repairs or patches, in the opinion of the **Engineer**, are not sound and properly finished.

E. Pipe shall not be shipped until it has attained full specified 28-day compressive strength.

PART 2 PRODUCTS

2.01 GENERAL

A. All reinforced concrete storm drain pipe shall conform to the requirements ASTM C76, except as specifically extended, modified or amended in this section.

B. All reinforced concrete storm drain pipe shall meet the standards for ASTM C76 Class III or as otherwise designated on the Drawings. All reinforced concrete storm drain pipe shall have a minimum of a B wall thickness unless shown otherwise on the Drawings or specified herein.

2.02 CONCRETE PIPE

A. Reinforced concrete storm drain pipe shall be manufactured in accordance with ASTM C76 and shall be furnished in not less than eight (8) foot lengths. Special pieces and closure pieces may be of shorter lengths than specified in

this section. Pipe shall be manufactured wet cast, dry cast, or centrifugally cast.

B. No lifting holes shall be provided in the wall of the pipe. Care shall be exercised in handling and transporting the pipe so as to protect the full interior wall of the pipe. No inward projecting hooks or lift bars shall be used in lifting pipe. Extreme care shall be applied to handling pipe immediately after manufacture to prevent development of "cure" cracks and stress cracks due to transporting pipe before full length of curing time.

C. All reinforced concrete storm drain pipe shall be made with concrete with a twenty-eight (28) day minimum compressive strength of 4000 psi and the absorption shall not exceed nine (9) percent. All cement and aggregate shall conform to the requirements of ASTM C76. Coarse aggregate shall meet the requirements of ASTM C33 of a size that provides a workable homogeneous, high quality concrete mixture, considering the particular wall thickness. Cement, for reinforced concrete pipe, shall be Type I/II portland cement. All admixtures shall be approved by the **Engineer** prior to use. Prior to manufacturing any pipe, including test pipe, the manufacturer shall submit the proposed concrete design mix to the **Engineer** for approval. The requirements of this article shall apply to all reinforced concrete pipe manufactured under the requirements of ASTM C76 and ASTM C443.

D. Reinforcement shall consist of either wire conforming to the standard specification for deformed steel wire for concrete reinforcement (ASTM A496), welded deformed steel wire fabric for concrete reinforcement (ASTM A497), bars of intermediate grade steel conforming to standard specifications for billet steel bars for concrete reinforcement (ASTM A615, Grade 60) or from fabricated deformed steel mats for concrete reinforcing (ASTM A184). Steel areas shall be in accordance with ASTM C76. Pipe with a diameter of 42-inches and larger shall be reinforced with two (2) full circular steel cages. Elliptical steel cages or quadrant steel cages shall not be allowed. Reinforcing steel shall be positioned in accordance with the clearances specified in ASTM C76. Clearance shall be provided for the full length of the pipe from bell end to spigot end of the pipe. Steel positioning shall not vary within the forms more than +/-10% of the wall thickness or +/-one-half (1/2)-inch, whichever is greater.

E. Variations of the internal diameter of the pipe shall comply with paragraph 12.1 of ASTM C76. The planes of the ends of the pipe shall be perpendicular to the longitudinal axis of the pipe except as specified for beveled end pipe (special pieces below). The ends of the pipe shall be of such a design that the pipe, when laid, shall form a continuous conduit with smooth and uniform interior surface. Minor repairs to the pipe are allowed as outlined in accordance with ASTM C76. Minor repairs made at the point of manufacture

or in the field shall be filled with a permanent non-shrinking patching compound. Mortar patching compound shall be similar and equal to Embeco 167 Mortar as manufactured by Master Builders, Thoropatch as manufactured by Thoroseal Products, or approved equal. The **Engineer** or QCast Inspector shall inspect the lengths of pipe before they are shipped to the project site and shall require the manufacturer to apply the mortar as directed. No mortar shall be applied without prior approval of the **Engineer** or QCast Inspector.

F. A record of pipe supplied for the project shall be furnished to the **Engineer** by the manufacturer. All pipe shipped to the site of the Work shall be clearly marked as to type, date of manufacture, and name or trademark of manufacturer. The historical record of pipe supplied shall be in a form approved by the **Engineer** and shall contain: class, date of manufacture, dates of inspection, date of shipment, and dates and results of compressive tests on cylinders and cores.

G. The **Contractor** shall not unload the pipe from trucks at the site of the Work in a manner that might damage the pipe. The method used to unload the pipe shall be subject to the approval of the **Engineer**. It shall be the responsibility of the **Contractor** to assure that the pipe is manufactured, loaded, transported, unloaded, stored, and installed in a manner which does not result in damage to the pipe.

H. The **Engineer**, in accepting the pipe, does not imply that the pipe is acceptable for its intended use. The **Engineer** reserves the right to reject any and all pipe until it meets all the requirements of these specifications.

2.03 SPECIAL PIECES

A. Special pieces of pipe such as bends shall be manufactured from cut lengths of straight pipe, and shall have carry-over reinforcement across adjoining planes of a design approved by the **Engineer**.

B. Manhole pieces shall be manufactured in accordance with the details shown the Drawings or as specified on the Detail Drawings.

2.04 JOINTS

A. All joints and gaskets shall meet the requirements of ASTM C443.

B. (Not Used)

2.05 SPECIAL DESIGN PIPE

A. Special designs of reinforced concrete pipe shall be in accordance with the requirements of ASTM C76 Section 7.2 - modified or special designs.

B. The pipe manufacturer shall not manufacture reinforced concrete pipe, test pipe, or produce pipe until approval has been obtained from the **Engineer** in writing. The manufacture of pipe shall have concrete cover over the inside steel cage and cover over the outside steel cage, in accordance to ASTM C76 standards, shall provide two complete circular mats of steel, and shall provide the strengths of steel as specified in this section. Pipe shall be designed per applicable sections of ASTM C76.

C. The pipe manufacturer shall be required upon receiving the order from the **Contractor** to submit to the **Engineer** for the **Engineer's** review and approval, the design for the classes of pipe to be manufactured. The design shall include drawings to be submitted for stamped approval. The stamped approval drawings shall be furnished to the **Engineer** for use during the manufacturing of the pipe. Manufacturing drawings shall be required for each pipe size and pipe class. The drawings shall be working drawings to reflect sizes of steel (circumferential, longitudinal, spacer, and stirrups steel) as well as steel placement.

D. Submission of certified three-edge-bearing tests already made, which are acceptable to the **Engineer**, may be considered as verification of Special Design in lieu of D-Load tests.

E. The **Engineer** may select at random two full length joints of each class or size of pipe to be tested to D-loads that would produce applicable (ASTM C76) cracking. Tests shall be in accordance with applicable sections of ASTM C76 or as amended in this section. The test shall be performed in the presence of the **Engineer** or QCast inspector.

PART 3 EXECUTION

3.01 LAYING CONCRETE PIPE

A. Excavation for the pipe and preparation of the trench bottom, including bedding to receive the pipe, shall be done in accordance with the requirements of **Section 02324, Trench Excavation and Backfil**ling. In the preparation of the pipe bedding, the **Contractor** shall take into consideration any variation in thickness of the pipe wall, and the bed must be prepared to suit the particular piece of pipe to be lowered into place. Preparation of the compacted bed shall be such that when the pipe is lowered in place and pulled to secure full compressive pack of the rubber joint ring, a smooth and uniform flow line on the specified grades will be secured. An interior

inspection of the sewer will be made after sufficient time has elapsed for the backfill to attain its settlement in the trench.

B. The pipe interior and joints shall be clean when lowered in the trench and shall be kept clean thereafter. The exposed ends of pipe in the trench shall be closed by suitable bulkheads at all times when pipe laying is not in progress. Each section of pipe shall be securely anchored in place before the next adjoining pipe is laid and the joint between the sections is made.

C. No tools or equipment shall be used in the laying of the pipe that will damage the pipe. The trenching equipment shall not be used to force a joint of pipe into its proper position on grade by application of pressure on top of the pipe along its partial or full length. All pipe joints shall be brought home by use of properly designed equipment for the specific purpose as approved by the **Engineer.** Pipe lengths that have received damage to wall, spigot, or socket shall be replaced or repaired to the satisfaction of the **Engineer**. Such replacement or repair shall be at the **Contractor's** expense.

D. The **Contractor** shall secure the following results with the pipe and joint used:

1. A tight joint with gasket fully compressed and joint openings completely filled.

2. Pipeline shall have a smooth and uniform interior section free from cracks, pits, voids, or crazing as defined in Sections 13 and 15 of ASTM C76. Longitudinal and transverse cracks with a width less than 0.01-inch shall be considered hairline and minor. Seal longitudinal and transverse cracks having a width equal to or greater than 0.01-inch and less than 0.10-inch if there is displacement across the crack and the soil pH is less than 5.5. Replace pipes having longitudinal and transverse cracks greater than 0.10-inch.

E. Backfilling shall be in accordance with the requirements of **Section 02324, Trench Excavation and Backfilling**.

3.02 CLEANING

A. At the conclusion of the work, the **Contractor** shall clean all pipe by flushing with water or other means to remove all dirt, stone wood or other materials which may have entered the pipe during construction.

B. (Not Used)

3.03 TESTING

A. Additional testing and inspection required for acceptability of installed storm sewers is specified in **Section 02650 - Testing for Acceptance of Sanitary Sewers**.

B. (Not Used)

3.04 CLEANUP

A. After completing each section of storm drain, 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 and neat condition. The **Contractor** shall restore the site of the Work to its original or better condition.

B. (Not Used)

+ + + END OF SECTION 02535 + + +

SECTION 02537
DUCTILE IRON SANITARY SEWER PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE

A. Provide all labor, materials, equipment and incidentals necessary to construct all ductile iron pipe and appurtenances as shown on the Drawings and as specified herein and the Spalding County Stormwater Manual.

B. Ductile iron pipe and appurtenances covered under this Section shall include all interior pipe and accessories to the outside face of structures and buildings, except where there is no joint at the outside face. Where there is no joint at the exterior face, this Section shall include all ductile iron pipe and accessories within two feet of the exterior face of the structure or building.

C. This Section includes piping and fittings in utility vaults and manholes.

1.02 SUBMITTALS

A. Complete product data on all piping and fittings shall be submitted to the **Engineer** in accordance with the requirements of Section **01300 – Submittals** of these Specifications.

B. The **Contractor** shall furnish the Inspector with lists of all pieces of pipe and fittings in each shipment received. These lists shall give the serial or mark number, weight, class, size and description of each item received.

C. The **Contractor** shall submit written evidence to the **Engineer** that the products furnished under this Section will conform with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the **Engineer** may require that the **Contractor** furnish test reports from an independent testing laboratory on samples of pipe materials.

1.03 QUALITY ASSURANCE

A. 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. ANSI A21.4 (AWWA C104) - Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings, for Water and Other Liquids

2. ANSI A21.10 (AWWA C110) - Ductile Iron and Gray Iron Fittings, 3-in. through 48-in., for Water and Other Liquids

3. ANSI A21.11 (AWWA C111) - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings

4. ANSI A21.15 (AWWA C115) - Flanged Ductile Iron Pipe with Threaded Flanges

5. ANSI A21.50 (AWWA C150) - Thickness Design of Ductile Iron Pipe.

6. ANSI A21.51 (AWWA C151) - Ductile Iron Pipe, Centrifugally Cast for Water and Other Liquids

7. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings

8. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe

9. ASTM D1248 - Polyethylene Plastics Molding and Extrusion Materials

10. ASTM G62 - Test Methods for Holiday Detection in Pipeline Coatings

11. AWWA C600 - Standard for Installation of Ductile Iron Water Mains and Their Appurtenances

12. SSPC-SP6 - Steel Structures Painting Council, Commercial Blast Cleaning

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE (DIP)

A. Ductile iron pipe shall be utilized for all piping where shown on the Drawings.

B. Ductile iron pipe shall be manufactured in accordance with ANSI/AWWA C150/A21.50 and 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	Pressure Class
8	350
14 - 18	350
20	300
24	250

30 - 54	250

C. Flanged pipe minimum wall thickness shall be equal to Special Thickness Class 53. Flanges shall be furnished and assembled onto the pipe by the manufacturer, not a pipe fabricator.

D. For restraint joint pipe, the manufacturer should determine the maximum required pipe length to provide horizontal and vertical deflection shown on the Drawings based on the type of restraint joint used.

2.02 FITTINGS AND ACCESSORIES

A. Fittings shall be ductile iron and shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ANSIA21.53 with a minimum rated working pressure of 250 psi.

B. Flanged elbow fittings shall be ANSI pattern using short radius elbows except where noted differently on the Drawings. Special fittings, ductile iron wall pipes and sleeves shall conform to the dimensions and details as shown on the Drawings.

C. Thrust Collars: Thrust collars shall be welded-on ductile iron body type capable of withstanding a thrust due to 250 psi internal pressure on a dead end from either direction on that pipe size. The welded-on collars shall be continuously welded to the pipe by the pipe manufacturer.

D. Solid sleeves shall permit the connection of plain end ductile iron pipe. Solid sleeves shall meet the requirements of ANSI/AWWA C110 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 and as shown on the Drawings. Solid sleeves shall be used only in locations shown on the Drawings or at the direction of the **Engineer**.

E. Restrained Flange Adapter (RFA): The RFA shall permit the connection of unthreaded, ungrooved, open-ended ductile iron pipe to ANSI/ASME B16.1, Class 125 flanges. The RFA shall meet the test requirements of ANSI/ASME B16.1 for Class 125 flanges. The RFA shall be a ductile iron casting incorporating gripping wedges and gasket. The gasket shall provide a compression seal between the RFA, the pipe and the adjacent flange. RFAs are to be used only in locations specifically shown on the Drawings and shall be installed in accordance with the manufacturer's recommendations. The RFA shall be EBAA Iron Megaflange-Flange Adapter Series 2100.

F. Service Clamps: Service clamps shall be ductile iron, double strap clamps equal to Mueller.

2.03 Joints

A. General

1. Unless shown or specified otherwise, joints for buried service shall be push-on type for pipe and standard mechanical or restrained joints for fittings. Joints for exposed service shall be flanged for pipe and fittings, unless shown otherwise.

2. 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. All bolts and nuts shall be made in the U.S.A.

3. In all cases, gaskets shall be made of material that will not be damaged by the fluid being transported nor by the environment in which the pipe is installed.

B. Push-On and Mechanical Joints

1. Joints shall conform to AWWA C111/ANSI A21.11. Bells shall be integrally cost with the pipe.

2. Bolts and nuts shall be Tee Head bolts and nuts of zinc plated, low carbon steel in accordance with ASTM A 242 to the dimension shown in AWWA C111/ANSI A21.11.

3. Gaskets shall be in accordance with AWWA C111/ANSI A21.11 and shall be constructed of plain rubber unless otherwise shown on the Drawings.

4. Mechanical joint glands shall be ductile iron.

C. Flanged Joints

1. Flanged joints shall conform to AWWA C115/ANSI A21.15. Flanges shall be ductile iron and shall be furnished by the pipe manufacturer.

2. 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.

   a. Bolts for exposed service shall be zinc plated, low carbon, steel machine bolts conforming to ASTM A 307, Grade B. Nuts for exposed service shall be zinc plated, heavy hex conforming to ASTM A 563. Zinc plating shall conform to ASTM B 633, Type II.

3. Gaskets shall be made of1/8-inch thick, red styrene-butadiene rubber (SBR) with a Durometer “Shore A” hardness of 65, a tensile strength of 1,000 PSI in accordance with ASTM F152, and an elongation of 400%. Gaskets may be ring type or full face type.

4. Flanged ductile iron pipe shall have flanges cast solidly or threaded to the pipe barrel. Pipe threads shall be of such length that with flanges screwed home, the end of the pipe shall project beyond the face line of the flange. Flange and pipe shall then be machined to give a flush finish to the pipe and the flange and surface shall be normal to the axis of the pipe. Ductile iron flanges shall be of such design that the flange neck completely covers the threaded portion of the pipe to protect same against corrosion. All pipe with threaded type flanges shall be assembled, faced, and drilled at the point of manufacture, unless otherwise approved by the **Engineer**.

5. Flange filler shall conform to AWWA C110/ANSI A21.10. Joint bolt length shall be increased by the thickness of the flange filler.

6. Where tap or stud bolts are required, flanges shall be drilled and tapped accordingly.

D. Restrained Joints

1. Manufactured restrained joints shall be American, FLEX-RING or LOK-RING, U.S. Pipe TR FLEX.

2. Restraining gasket joints shall be manufactured by American Ductile Iron Pipe Company Fast-Grip Gasket, Griffin TALON RJ Gasket, McWane SURE STOP 350 Gasket, U.S. Pipe FIELD LOK 350 Gasket, or **Owner** Approved Equal.

3. No field welding of restraint pipe will be permitted.

4. Bolts, nuts and joint accessories shall be in accordance with manufacturer’s recommendations.

5. Gaskets shall be in accordance with manufacturer’s recommendation.

2.04 WALL SLEEVES AND WALL PIPES

A. Where piping passes through concrete structures, furnish and install wall sleeves unless wall pipes or other provisions are specifically shown on the Drawings.

B. Wall Sleeves

1. For pipe sizes smaller than 3-inches, wall sleeves shall be steel oversize sleeves furnished with a full circle, integral or continuously welded waterstop collar. The sleeve seal shall be the mechanically expanded, synthetic rubber type. Provide all associated bolts, seals and seal fittings, pressure clamps or plates necessary to achieve a watertight installation. Sleeves shall extend the full thickness of the concrete. Sleeves and seal shall be Link Seal.

2. For larger pipe sizes, wall sleeves shall be statically cast ductile iron mechanical joint wall sleeves. Unless specified or shown otherwise for a specific situation, wall sleeves shall be mechanical joint bell-plain end type with waterstop/thrust collar. Sleeves shall be constructed with studs and mechanical joint [retainer] gland on the air side of the concrete structure. Provide retainer gland where shown on the Drawings. Where the concrete structure is exposed to dirt on one side and is wet on the other side, construct with studs and glands on the dirt side.

C. Wall Pipes: Wall pipes shall be cast and/or fabricated and lined in one manufacturer's facility and delivered to the job site ready for use.

2.05 COATINGS

A. The exterior of pipe and fittings for buried service shall be factory zinc coated with an asphaltic coating conforming to AWWA C151/ANSI 21.51 for ductile iron pipe, AWWA C115/ANSI 21.15 for flanged pipe and AWWA C110/ANSI 21.10 for fittings. Pipe and fittings which shall be exposed or submerged shall be factory coated with a general purpose rust inhibitive primer compatible with the type of paint which will be field applied in accordance with the requirements of Section 09900 of these Specifications.

B. (Not Used)

2.06 LININGS

A. Pipe and fittings shall be cement lined in accordance with AWWA C104/ ANSI A21.4, standard thickness, unless specified or shown otherwise.

B. Special Lining

1. Where shown on Drawings or where specified, pipe and fittings shall be lined with ceramic epoxy as specified below.

2. Special linings shall cover all exposed surfaces of pipe and fittings subject to contact with sewer liquid or gas. The lining of the pipe barrel shall extend from spigot end through the socket to the edge of the gasket sealing area or recess for pipe using push-on gaskets, and to the edge of the gasket seat for

mechanical joints. The lining shall also cover the exterior of the spigot end from the end of the pipe to beyond the gasket sealing area. The lining in fittings shall cover the interior surfaces including the socket areas as defined above. All linings shall be hermetically sealed at the ends.

C. Ceramic Epoxy Lining (all pipe diameters)

1. Lining Material: The lining material shall be Protecto 401 Ceramic Epoxy, an amine cured novalac epoxy containing at least 20 percent by volume of ceramic quartz pigment. The material shall meet the following minimum requirements:

a. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

b. The following test shall be run on coupons from factory lined ductile iron pipe:

i. ASTM B-117 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two years.

ii. ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5 mm undercutting after 30 days.

iii. Immersion Testing rated using ASTM D-714-87.

a) 20% Sulfuric Acid – No effect after two years.

b) 140°F 25% Sodium Hydroxide – No effect after two years.

c) 160°F Distilled Water – No effect after two years.

d) 120°F Tap Water (scribed panel) – 0.0 undercutting after two years with no effect.

c. An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

2. Surface Preparation: Surface preparation shall consist of the ductile iron surface to a near-gray blast finish. This degree of cleanliness is comparable to a SSPC-SP10 for steel with the exception that ductile iron attains a gray color when blast cleaned. The blast cleaning operation shall remove 95% of all surface contaminants, including tightly adhered annealing

scale. The anchor tooth pattern, resulting from the blasting operation, shall have a minimum height of 3.0 mils.

3. Applicators: The lining shall be applied using a centrifugal lance applicator by applicators certified by the lining manufacturer. The workers shall be experienced and competent in the surface preparation, application and inspection of the lining to be applied.

4. Lining: After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. Minimum thickness shall be 30 mils. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface shall be dry and dust free. If flange pipe or fittings are lined, the lining shall not be used on the face of the flange.

5. Bell Sockets and Spigot Ends: The gasket area and spigot end up to 6 inches back from the end of the spigot end shall be coated with 6 mils nominal, 10 mils maximum, using Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be performed after the application of the lining.

6. Number of Coats: The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

7. Touch-Up and Repair: Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

8. Lining Holiday Test: At the manufacturer's facility, the lining shall be tested over 100% of the pipe barrel surface with a high-voltage spark tester as recommended by ASTM Designation G-62 Method B. If holidays are found in the lining by the above test at the manufacturing plant, the holiday shall be repaired per the lining manufacturer's recommendation. The holiday detector shall be a commercially available detector available from holiday detection equipment manufacturers such as SPY, TINKER AND RASOR, and ZORELCO.

9. All pipe linings shall be checked for thickness using a magnetic film thickness gauge. Thickness testing shall be performed in accordance with SSPC-PA-2.

10. Each pipe joint and fitting shall be marked with the date of application of the lining system and with the numerical sequence of application of that date.

11. Certification: The pipe or fitting manufacturer shall supply a certificate attesting to the fact that the applicator met the requirements of this Specification, and that the material used was as specified.

12. Handling: Protecto 401 lined pipe and fittings shall be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.

2.07 RETAINER GLANDS

A. Retainer glands for ductile iron pipe shall be EBBA Megalug Series 1100, Sigma ONE-LOK Series D-SLDE, Romac Romagrip, or **Owner** approved equal.

2.08 POLYETHYLENE ENCASEMENT

A. Ductile iron pipe shall be encased with polyethylene film where shown on the Drawings. Polyethylene film shall have a minimum thickness of 8 mils.

B. (Not Used)

PART 3 - EXECUTION

3.01 CUTTING

A. When new or existing pipe is required to be cut, the pipe shall be cut in such a manner as to leave a smooth end normal to the axis of the pipe.

B. All cutting of ductile iron pipe shall be performed with a cutting saw. All burrs shall be removed from the inside and outside edges of all cut pipe. All damaged linings and coatings shall be repaired.

C. Lining Repair: Repair epoxy linings and recoat spigot ends of cut pipe with Protecto 101 or Madewell 1104 coal tar epoxy in accordance with the manufacturer's recommendations and as specified below:

1. Remove all burrs and areas of loose lining materials by sanding or scraping to bare metal.

2. Remove oil and lubricants used during field cutting.

3. Lining shall be stripped back a minimum of 1-inch from the spigot end into well adhered lined areas.

4. Roughen 1 to 2-inches of good lining with a rough grade (40 grit) emery paper, rasp or small chisel, to allow an overlap between new and existing lining.

5. Apply lining repair material in the number of coats required to match the thickness requirements as specified in Part 2 of this Section and in accordance with the manufacturer's recommendations.

3.02 JOINT ASSEMBLY

A. General: Ductile iron pipe shall be assembled in accordance with ANSI/AWWA C600.

B. Push-On Joints: The inside of the bell and the outside of the pipe from the plain end to the guide stripe shall be wiped clean immediately before assembling the pipe joint. Then the rubber gasket shall be inserted into a groove or shaped recess in the bell. Both the bell and spigot ends to be joined shall be wiped again to ensure they are thoroughly clean. A liberal coating of special lubricant furnished by the pipe manufacturer shall be applied to the outside of the pipe. The plain end shall be centered in the bell and the spigot pushed home.

C. Mechanical Joints

1. The surfaces with which the rubber gasket comes in contact shall be brushed thoroughly with a wire brush just prior to assembly to remove all loose rust or foreign material which may be present and to provide clean surfaces which shall be brushed with a liberal amount of soapy water or other approved lubricant just prior to slipping the gasket over the spigot end and into the bell. Lubricant shall be brushed over the gasket prior to installation to remove loose dirt and lubricate the gasket as it is forced into its retaining space.

2. Joint bolts shall be tightened by the use of wrenches and to a tension recommended by the pipe manufacturer. When tightening bolts, the gland shall be brought up toward the pipe bell. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation shall not be permitted.

3. After installation, bolts and nuts in buried piping shall be given two heavy coats of a bituminous paint. Bolts and nuts for exposed or submerged

service shall be coated in accordance with the requirements of Section 09900 of these Specifications.

D. Flanged Joints

1. All flanges shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations, or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the finished pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe.

2. Connections to equipment shall be made in such a way that no torque is placed on the equipment flanges. Connecting flanges must be in proper position and alignment and no external force may be used to bring them together properly.

3. Flanged filler shall be used only where shown on the Drawings or approved by the **Engineer** to make up minor differences in pipe length, less than 3-inches. Joint bolts shall be increased in length by the thickness of the flange filler.

3.03 DRILLING AND TAPPING

A. Wherever required ductile iron pipe and fittings shall be drilled and tapped to receive any other piping. All holes shall be drilled accurately at right angles to the axis of any pipe or fitting. Where plugs are drilled, holes shall be at right angles to the face of the plug.

B. Unless shown otherwise, small diameter pipes, less than 2-inches, shall be connected to ductile iron pipe using one of the following methods:

1. Direct tap.

2. Direct tap with service clamp.

3. Direct tap boss.

4. Tapped plug or flange on tapping saddle.

C. In no case shall the effective number of threads be less than 4.

3.04 CONSTRUCTING BENEATH AND BEYOND STRUCTURES

A. All ductile iron pipes entering buildings or basins shall be adequately supported between the structure and undisturbed earth to prevent damage resulting from settlement of backfill around the structure.

3.05 CONSTRUCTING WITHIN STRUCTURES

A. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Care shall be taken to prevent the pipe coating from being damaged, particularly cement linings on the inside of the pipes and fittings. Any damage shall be remedied as directed by the **Engineer**.

B. All pipe and fittings shall be carefully examined by the **Contractor** for defects just before installing and no pipe or fitting shall be installed if it is defective. If any defective pipe or fitting is discovered after having been installed, it shall be removed and replaced in a satisfactory manner with a sound pipe or fitting by the **Contractor** at **Contractor's** own expense.

C. All pipes and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are used in the completed work. Open ends of pipe shall be kept plugged with a bulkhead during construction.

D. All elbows, tees, brackets, crosses, and reducers in pressure piping systems shall be adequately restrained against thrust.

E. Wall pipe and wall sleeves shall be accurately located and securely fastened in place before concrete is poured. All wall pipe and sleeves shall have wall collars properly located to be in the center of the wall where the respective pipes are to be installed. Pipe passing through the sleeve shall extend no more than three feet beyond the structure without a piping joint.

F. Wall pipe and wall sleeves shall be constructed when the wall or slab is constructed. Blocking out or breaking of the wall for later installation shall not be permitted.

G. Cutting or weakening of structural members to facilitate pipe installation shall not be permitted. All piping shall be installed in place without springing or forcing.

3.06 INSPECTION AND TESTING

All testing shall be in accordance with the requirements of **Section 02650 – Testing for Acceptance of Sanitary Sewers**.

+++ END OF SECTION 02537 +++

SECTION 02545
POLYVINYL CHLORIDE GRAVITY SEWER PIPE

PART 1 - GENERAL

1.01 SCOPE

A. This section includes Specifications for polyvinyl chloride gravity sewer pipe for sanitary sewer installations as shown on the Plans and as specified in these Specifications.

B. The **Contractor** shall provide all services, labor, materials, and equipment required for all polyvinyl chloride gravity sewer pipe installation and acceptance 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.

C. Related Work Specified Elsewhere;

1. Section 02200 - Earthwork

2. Section 02140 - Dewatering

3. Section 02324 - Trenching and Trench Backfilling

4. Section 02650 - Testing for Acceptance of Sanitary Sewers.

1.02 SUBMITTALS

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

1. Product Data: The **Contractor** shall submit, for the **Engineers**' approval, descriptive details and shop drawings covering full details of pipe, fittings, specials, joints and assembly thereof, joint materials and details thereof, and full details and cuts of all castings to be incorporated into the Work.

2. Manufacture's Certificate: The **Contractor** shall submit a manufacture's certificate certifying that products meet or exceed the requirements of ASTM D3034, ASTM F1336, and the requirements of these Specifications.

1.03 QUALITY ASSURANCE

A. 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. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

2. ASTM D3212a - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

3. ASTM F1336 - Standard Specification for Poly(Vinyl Chloride) (PVC) Gasketed Sewer Fittings.

4. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

5. ASTM D448 - Standard Sizes of Course Aggregate for Highway Construction.

6. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.

7. ASTM F1417-92(1998) - Standard Test Method of Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

1.04 TESTING

A. Pipe joints, and fittings shall comply with the latest revisions of ASTM D3034, ASTM F1336, and be tested in accordance with the requirements of ASTM F1417.

1.05 ACCEPTANCE

A. Acceptance shall be on the basis of in-plant testing and inspection of manufactured pipe for visual defects and imperfections in accordance with the requirements of ASTM D3034 and ASTM F1336.

B. The **Contractor** shall provide manufacturers' results of testing on pipe, joint materials, and assemble joints as required by the **Owner**. These tests shall include material and hydrostatic leakage tests on pipes of each size in accordance with the requirements of ASTM D3034 and ASTM F1417.

C. The **Contractor** shall inspect the pipe after delivery for shape, cracks, uniformity, blisters and imperfect surfaces, damaged ends, and gasket grooves. The **Contractor** shall not use repaired or patched pipe or pipe with repaired or patched gasket grooves or shoulders. Imperfections in the barrel or socket of a pipe or fitting will be rejected.

PART 2 - PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC), FOR SEWER SERVICE LATERALS OUTSIDE RIGHT OF WAY

A. Polyvinyl chloride (PVC) gravity sewer pipe 8 to 15 inch in diameter shall be minimum SDR 26 and conform to all requirements of ASTM D3034, ASTM F1336, and the Georgia Department of Natural Resources, “Guidelines for Gravity Sewers”, dated March 29, 1996. Acceptance shall be on the basis of hydrostatic pressure testing as described in ASTM F1417.

B, Polyvinyl chloride gravity sewer pipe 18 in diameter and greater shall be minimum PS 46 in accordance with ASTM F679.

2.02 POLYVINYL CHLORIDE PIPE (PVC), FOR TRUNK SEWER APPLICATIONS

A. Polyvinyl chloride (PVC) gravity sewer pipe 16 inch in diameter shall be AWWA C900 and minimum SDR 25 and conform to all requirements of ASTM D1784, ASTM F447, ASTM D3139, and the Georgia Department of Natural Resources, “Guidelines for Gravity Sewers”, dated March 29, 1996. Acceptance shall be on the basis of hydrostatic pressure testing as described in ASTM F1417.

2.03 JOINTS

A. Joints for PVC and Fittings shall be bell and spigot type, conforming to the requirements of ASTM D3212 using plain rubber gaskets conforming to ASTM F477.

2.04 FITTINGS AND SPECIALS

A. The **Contractor** shall provide fittings and specials to meet the Project requirements and in accordance with the requirements of ASTM F1336.

B. The **Contractor** shall provide service connections and associated fittings as required to reconnect existing service connections to the PVC. Connections shall be made by using factory made wyes or tees as directed by the **Engineer**.

2.05 PIPE MARKINGS

A. All pipe and fittings shall be clearly marked with the name or trademark of the manufacturer, the plant where the pipe was made, and the strength designation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The **Contractor** shall install PVC pipe in accordance with the requirements of ASTM D2321.

B. Excavation for the pipe and preparation of the trench bottom, including bedding to receive the pipe shall be done in accordance with the requirements of this section and **Section 02324 - Trenching and Trench Backfilling**.

C. Trench backfilling shall be performed in accordance with the requirements of **Section 02324 - Trenching and Trench Backfilling** and the Manufactures' recommendations.

D. PVC pipe shall be bedded in accordance with AWWA C605, Type 5 Bedding.

E. The pipe shall be placed true to line and grade. Bell holes shall be dug and the barrel of the pipe provided with uniform and continuous support.

F. Standard sizes for bedding materials shall be in accordance with the requirements of ASTM D448, **Section 02060 - Crushed Stone Aggregate**, and **Section 02234 - Trenching and Trench Backfilling**.

3.02 ACCEPTANCE TESTING

A. After installation, backfilling, and cleaning, acceptance testing shall be performed by low pressure air testing as specified in **Section 02650 - Testing for Acceptance of Sanitary Sewers**.

B. Air Testing

1. Testing shall be performed by the low pressure air test method conforming to the requirements of ASTM F1417.

2. Each section between manholes or structures shall be plugged. Air will be introduced into the plugged system. The system passes the test if the air loss, as measured by the pressure drop from 3.5 psi to 2.5. psi, does not occur within the time interval found in ASTM F1417 or the NCPI pamphlet, “Low Pressure Air Test for Sanitary Sewers”.

3. Lines which fail any acceptance testing shall be evaluated and the source of leakage corrected. The line shall then be retested for compliance with the requirements of these specifications.

+++ END OF SECTION 02545 +++

SECTION 02641
PRECAST CONCRETE MANHOLES

PART 1 - GENERAL

1.01 SCOPE

A. This section includes precast concrete manholes installation; frames and covers; pipe connections at manholes; manhole testing; backfill; cleanup; and any other similar, incidental, or appurtenant operation which may be necessary to properly complete the Work.

B. The **Contractor** shall provide all services, labor, materials, and equipment required for all precast concrete manholes and related operations necessary or convenient to the **Contractor** for furnishing a complete Work as shown on the Plans or specified in these Specifications.

C. Related Sections Specified Elsewhere:

1. Section 02140 - Dewatering
2. Section 02324 - Trenching and Trench Backfilling
3. Section 02535 - Gravity Flow Sanitary Sewers
4. Section 02650 - Testing for Acceptance of Sanitary Sewers.
5. Section 02920 - Site Restoration
6. Section 03300 - Cast-In-Place Concrete

1.02 SUBMITTALS

A. 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. The **Contractor** shall submit manufacturer's data and details of the following items for approval:

a. Shop drawings of manhole sections and base units and construction details, including reinforcement, jointing methods, and materials.

b. Summary of criteria used in the manhole design including, as a minimum, material properties, loadings, load combinations, and dimensions assumed.

c. Materials to be used in fabricating drop connections.

d. Materials to be used for pipe connections at manhole walls.

e. Materials to be used for stubs and stub plugs, if required.

f. Materials and procedures for corrosion resistant liner and coatings, if required.

g. Plugs to be used for vacuum testing.

h. Manufacturer's data for pre-mix (bag) concrete, if used for channel inverts and benches.

i. Description of the proposed method of concrete curing.

1.03 QUALITY ASSURANCE

A. 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. ASTM C270 - Standard Specification for Mortar for Unit Masonry.

2. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe using Rubber Gaskets.

3. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections

4. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

5. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic Cement Grout (non-shrink).

B. Prior to delivery, all basic materials specified in this section 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.

C. After delivery to the site of the Work, 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 of the Work.

D. Precast concrete producer shall demonstrate adherence to the standards set forth in the National Precast Concrete Association Quality Control Manual. Precast concrete producer shall meet requirements written below.

1. Qualifications, Testing and Inspection

a. The Precast concrete producer shall have been in the business of producing precast concrete products similar to those specified for a minimum of 5 years. The precast concrete producer shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis. The agency shall issue a report, certified by a licensed engineer, detailing the ability of the precast concrete producer to produce quality products consistent with industry standards.

b. The Precast concrete producer shall show that the following tests are performed in accordance with the ASTM standards indicated. Tests shall be performed for each 150 cu. yd. of concrete placed, but not less frequently than once per week.

(1.) Slump: C143

(2.) Compressive Strength: C31, C192, and C39

(3.) Air Content (when air-entrained concrete is being used): C231 or C173

(4.) Unit Weight: C138

c. The Precast concrete producer shall provide documentation demonstrating compliance with this subparagraph.

d. The plant shall notify the **Engineer** when the pre-cast products are being produced for the project. The **Owner** may place an inspector in the plant when the products covered by this specification are being manufactured."

1.04 DESIGN CRITERIA

A. Manholes shall be constructed of specified materials to the sizes, shapes, and dimensions and at the locations shown on the Plans or as otherwise directed by the **Engineer**. The height or depth of the manhole will vary with the locations, but unless shown otherwise on the Plans shall be such

that the top of the manhole frame will be at the finished grade of the pavement or higher than the ground surface as shown on the Plans and the invert will be at the designed elevations.

PART 2 – PRODUCTS

2.01 PRECAST CONCRETE MANHOLES

A. Unless specified otherwise in the Plans or in the Special Conditions, all manholes will be precast concrete manholes as specified in this section.

B. The precast reinforced concrete manholes shall be constructed in accordance with the requirements of ASTM C478. Reinforced concrete manholes shall consist of manhole base sections, riser sections, transition sections, and conical sections as described in this section. The manhole components shall be configured to minimize the number of joints required per manhole (see Detail Drawings). The **Engineer** may require any manhole that is not composed of the minimum number of sections to be replaced.

C. Portland cement concrete used in the precast reinforced concrete manholes shall have a minimum compressive strength of 4000 psi at twenty-eight (28) days.

1. The concrete shall contain type II Portland cement with a C3A content of five and one-half (5½) percent or less and meet the requirements of ASTM C478.

2. Aggregate for concrete, except for maximum size and gradation, shall be as specified in applicable sections of these Specifications.

3. To aid in achieving the specified concrete compressive strength, newly cast manholes shall be cured in accordance with the requirements of ASTM C478. The method of curing proposed must be submitted to the **Engineer** prior to manufacture. Manholes shall be cured for a minimum of seven (7) days prior to shipment to the site unless otherwise instructed by the **Engineer**.

4. The manhole manufacturer shall test the compressive strength of a minimum of two (2) concrete cylinders per calendar week. Reports verifying the results of the compression tests shall be maintained at the manufacturer's facility. Reports shall be made available for inspection and review by the **Owner's** representatives. The manhole manufacturer shall permit the **Owner's** representatives to make unannounced reviews of compression test records and

inspection of manufacturing facilities at any time during normal business hours.

5. The manhole manufacturer shall notify the **Owner** of all manholes delivered for use in the **Owner's** sanitary sewer system which were manufactured during a week for which a concrete compressive strength test yielded a result of less than 4,000 psi.

   a. Such notification shall be in the form of a letter sent to:

      Spalding County Water Authority
      Construction Management Group
      119 E Solomon St
      Griffin, GA 30223

   b. Notification shall include (at a minimum) the project name, Contractor name, date of manhole component manufacture, and description of manhole component(s) affected.

   c. The **Owner** may require additional testing, repairs, or removal and replacement, at no additional cost to the **Owner**, of any or all manhole components provided for use in the **Owner's** sanitary sewer systems which were manufactured during a calendar week for which a concrete compressive strength test yields a result of less than 4,000 psi.

D. Reinforcing steel shall be bars of intermediate grade, open hearth, billet steel, conforming to the requirements of ASTM A615, or Cold-Drawn Steel Wire for Concrete Reinforcement conforming to the requirements of ASTM A82; or of wire fabric conforming to the requirements of ASTM A185. The circumferential reinforcement in the riser and conical top sections shall have an area of not less than 0.12 square inches per linear foot.

E. The interior and exterior surfaces of the manhole shall have a smooth hard finish, and shall be free from cracks, chips, and spalls.

F. The maximum allowable absorption of the concrete used for manhole construction shall not exceed eight (8) percent of the dry weight.

G. 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 the requirements of **Section 03300 - Cast-In-Place Concrete**.

H. 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 manufactured by Press-Seal Gasket Corporation, shall be supplied to the **Contractor** upon request.

I. 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.

J. 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

K. 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.

L. 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.

M. 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.

N. 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.

O. Manhole steps shall conform to the requirements of this section.

2.02 STRUCTURAL MATERIALS AND CASTINGS

A. Structural steel shall conform to the requirements of ASTM A283, unless otherwise indicated on the Plans.

B. 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.

C. 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.

D. Aluminum castings shall conform to the requirements of ASTM B108.

E. 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.

2.03 FRAMES, COVERS, AND STEPS

A. 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.

B. Manhole frames and covers shall be as detailed on the Plans, and as manufactured by East Jordan (formerly East Jordon Iron Works (EJIW), 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.

C. Sanitary sewer manhole covers shall have the words cast on the top in letters two (2) inches high per the County Standard Detail.

D. Manhole inlet steps shall be made of steel reinforced copolymer polypropylene model PS-1 PF. They shall be installed at maximum twelve (12) inch intervals. Manhole steps shall be as shown in the Detail Drawings with rod and pull ratings meeting OSHA standards.

2.04 SPECIALTY ITEMS

A. 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.

B. 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.

C. 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.

D. 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.

2.05 BRICK

A. Brick shall comply with the following requirements for which its use is intended. Bricks with holes through them will not be allowed in the Work.

B. Bricks used to adjust manhole frame to grade shall conform to the requirements of ASTM C32 for grade SM. Bricks shall conform to the following dimensions, unless otherwise approved by the **Engineer**.

	Depth (Inches)	Width (Inches)	Length (Inches)
Standard Size	2-1/4	3-3/4	8
Allowable Variation	+1/4	+1/4	+1/2

C. All brick shall be new and whole, of uniform standard size, and with substantially straight and parallel edges and square corners. Bricks shall be of compact textures, burned hard entirely through, tough and strong, free from injurious cracks and flaws, and shall have a clear ring when struck together. No soft or salmon brick shall be used in any part of the Work. Brick shall be culled after delivery, if required, and no culls shall be used except at such places, to such extent, and under such conditions as may be approved by the **Engineer**.

2.06 CONCRETE

A. Concrete shall conform to requirements of **Section 03300 - Cast-In-Place Concrete**.

2.07 MORTAR

A. Mortar shall be prepared only in the quantities needed for immediate use. Mortar which has been mixed for more than thirty (30) minutes or which has set or has been retempered shall not be used in the Work.

PART 3 - EXECUTION

3.01 GENERAL

A. All activities shall be performed in accordance with the manufacturer's recommendations and regulations established by OSHA. Particular attention shall be drawn to those safety requirements involving working with scaffolding and entering confined spaces.

B. The **Contractor** shall verify that lines and grades are as specified in the Plans.

3.02 INSTALLATION

A. Manholes shall be constructed to the sizes, shapes, and dimensions as detailed in the Detail Drawings and at the locations shown on the Plans. They shall be constructed of precast concrete sections conforming to the requirements of this section. The manholes shall be assembled with the fewest number of sections to make up required height, thereby reducing the number of joints. The composition of the manhole must be approved by the **Engineer**. The **Engineer** may require any manhole that is not composed of the minimum number of sections to be replaced. The depth of the manhole will vary with the location but in all cases it shall be such as will place the cover (or lid) at the finished grade of the pavement or ground surface or as otherwise indicate on the Plans. In undeveloped or rural areas, manholes shall be furnished to a height of two (2) feet above ground. Concentric cone sections and flat top manholes, except for shallow depth where approved by the **Engineer**, will not be allowed; only eccentric cones will be used.

B. Precast concrete manholes for reinforced concrete sewers forty-eight (48) inches diameter and larger shall be as specified above, except that they shall be installed on a saddle constructed on the barrel of the sewer. Precast concrete manholes for sewers thirty (30), thirty-six (36), and forty-two (42) inches shall be saddle-types or precast base types as specified in the Plans. Reinforcing steel in the saddle shall be welded to the reinforcing steel of the pipe. The design of these saddles shall be approved by the **Engineer** prior to manufacture.

C. All joints for precast manhole stacks shall be offset tongue and groove with Kent Seal No. 2 as manufactured by Hamilton Kent. Each joint shall also be sealed with Conseal CS-231 waterstop sealant as manufactured by Concrete Sealants. The width and installation of the joint sealant shall be in accordance with the manufacturer's recommendations. All joints shall be supplied with 3" x 16" x ½" inch bitumastic coated steel strap

anchors. Three (3) strap anchors, one-hundred and twenty (120) degrees apart shall be required per joint.

D. Where the difference in the invert elevation of two (2) or more sewers, eighteen (18) inches in diameter or smaller, intersecting in one (1) manhole is two (2) feet or more, a Drop Manhole (Memphis Tee) shall be constructed in the manner shown in the Detail Drawings. They shall be similar in construction to the standard manhole, except that a drop connection of a pipe and fittings of the proper size and material shall be constructed outside the manhole and supported by Class B concrete as indicated on the Plans and in the Detail Drawings. The manhole and the drop connection shall be placed on twelve (12) inch reinforced concrete base as detailed in the Detail Drawings. The drop connection piping assembly shall be bolted to the barrel of the manhole riser using a minimum of four $^{5}/_{8}$-inch diameter stainless steel (316) bolts with suitable washers to prevent failure caused by pulling the bolt head through the manhole wall.

E. Base sections shall be precast with the vertical walls of sufficient height to allow entry of the required pipes as shown on the Plans, and as detailed in the Detail Drawings. Manhole inverts shall be constructed of cement mortar and 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 direction 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.

F. All water standing in the trench shall be removed before placing of concrete is started, and the foundation maintained in a dry condition.

G. Shallow manholes shall be constructed to the sizes, shapes, and dimensions as detailed in the Detail Drawings, and at the locations shown on the Plans. They shall be constructed of precast concrete sections as shown on the Plan and as directed by the **Engineer**.

H. The top elevation of manhole frames shall be adjusted to grade in areas such as streets, alleys, and parking lots or where indicated on the Plans. A maximum adjustment of twelve (12) inches will be allowed using brick and mortar. Adjustments greater than twelve (12) inches must be made by changing precast riser sections. Brick used will be in accordance with the requirements of this section.

3.03 PIPE CONNECTIONS AT MANHOLES

A. Openings in manhole walls for incoming and outgoing sewers shall be precast or cored and after installation sealed with an approved non-shrink grout. These manholes shall be installed on a choked and compacted stone bedding as detailed in the Detail Drawings.

B. A flexible manhole connector may be approved by the **Engineer** as an alternate method of sealing the space between the manhole wall and the pipe. Flexible manhole sleeves shall be required for all pipes eighteen (18) inches and smaller. The manhole connector shall be Kor-N-Seal or equal and conform to the requirements of ASTM C923 and shall be made from ethylene propylene rubber (EPDM) designed to be resistant to ozone, weather elements, chemicals, including acids, alkalis, animal and vegetable fats, oils, and petroleum products. Manhole sleeves shall be secured to pipe by stainless steel clamp and bolt assembly conforming to the requirements of ASTM C923 and ASTM A167.

C. All stainless-steel elements of the manhole connector shall be totally non-magnetic Series 304 Stainless, excluding the worm screw for tightening the steel band around the pipe which shall be Series 305 Stainless. The worm screw for tightening the steel band shall be torqued by a break-away torque wrench available from the precast manhole supplier, and set for 60-70 inch/lb. The connector shall be installed in the manhole wall by activating the expanding mechanism in strict accordance with the recommendation of the connector manufacturer. The connector shall be of a size specifically designed for the pipe material and size being utilized on the Project.

3.04 MANHOLE TESTING

A. All manholes shall be vacuum tested in accordance with the requirements of **Section 02650 - Testing for Acceptance of Sanitary Sewers**.

3.05 CLEANUP

A. After the manhole installation work has been completed and all testing accepted by the **Engineer**, the **Contractor** shall cleanup the area. All excess material and debris not incorporated into the permanent installation shall be disposed of by the **Contractor**. Disturbed grassed areas shall be seeded or sodded. Site restoration shall be performed in accordance with the requirements of **Section 02920 - Site Restoration**.

+++ END OF SECTION 02641 +++

SECTION 02650
TESTING FOR ACCEPTANCE OF SANITARY SEWERS

PART 1 - GENERAL

1.01 SCOPE

A. This section includes sanitary sewer inspection and testing methods; joint testing procedures; manhole testing methods; allowable testing limits for sanitary sewers; and any other similar, incidental, or appurtenant operation that may be necessary to properly complete the Work.

B. 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.

C. Related Work Specified Elsewhere:

1. Section 02535 - Gravity Flow Sanitary Sewers

2. Section 02545 - Polyvinyl Chloride Gravity Sewer Pipe

3. Section 02641 - Precast Concrete Manholes

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Requirements and **Section 01300 - Submittals** of the Contract Documents.

1.03 QUALITY ASSURANCE

A. 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.

B. American Standards for Testing and Materials International (ASTM)

1.04 GENERAL

A. 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.

B. 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)

C. The testing method for individual projects shall be as specified in the Special Conditions.

D. 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.

1.05 TEST SECTIONS

A. Unless otherwise specified or directed by the **Owner**, 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 one thousand, two hundred (1,200) feet of sewer prior to performing air testing.

B. The **Contractor** may choose to 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 one thousand, two hundred (1,200) foot section until test results for the entire one thousand, two hundred (1,200) feet are satisfactory, or as directed by the **Owner**.

C. The **Owner** may allow alternate testing methods, or may require additional testing methods if deemed warranted.

PART 2 – PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 SANITARY SEWERS INSPECTION AND TESTING METHODS

A. 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.

B. The **Contractor** shall have cleaned and tested lines and pass all requirements 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 **Owner**, the **Contractor** shall flush out lines and manholes before final inspection at the **Contractor's** cost.

C. Alignment: Pipelines 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.

D. Low-Pressure Air Test: Sewer diameters less than or equal to twenty four (24) inches:

a. 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, 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) psig. After this pressure is reached and the pressure allowed to stabilize within approximately two (2) to five (5) minutes, the pressure may be reduced to three and one-half (3.5) psig before starting the test. If the pressure drop is equal to or less than one (1) psig 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 twenty-four (24) inches, check with manufacturer.

b. The **Contractor** shall provide required test equipment, including inflatable balls, braces, air hose, air source, time, rotameter as applicable, cut-off valves, pressure reducing valve, zero to fifteen (0 to 15) psi pressure gauge, zero to five (0 to 5) psi pressure gauge with gradations in one-tenth (0.1) psi and accuracy of ± two (2) percent. Testing equipment shall be equal to Cherne Air-Loc Testing Systems.

c. The **Contractor** shall keep records of all tests made. Copies of such records shall be given to the **Owner**. Such records shall show date, line number and stations, operator, and such other pertinent information as required by the **Owner**.

d. The **Contractor** shall 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.

E. 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.

F. Smoke Testing: Smoke testing shall be used only to locate leaks and shall not, in any case, 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 **Owner** may order a smoke test if another leakage test fails and the source of the leak cannot be determined by other means. Smoke testing shall only be performed where ground water is low. Smoke shall be blown into a sealed section of sewer under pressure and the **Contractor** and **Owner** shall observe for any smoke appearing on top of the ground indicating the presence of leaks. The **Owner** 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 **Contractor's** expense in a manner acceptable to the **Owner**. Equipment and supplies required for smoke tests shall be furnished by the **Contractor**. The **Contractor** may choose to perform smoke tests at any time during construction; however, any such tests shall not supplant the final test of the completed Work.

G. 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 shall only be performed where ground water is low. Dye shall be introduced into the service lateral and the **Contractor** and **Owner** 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 opt to conduct dye tests at any time during construction; however, any such tests shall not supplant the final test of the completed Work.

H. Deflection Test: All PVC gravity sewers:

1. 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.

2. 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 **Owner**, and

shall have sufficient rigidity so the legs of the mandrel shall 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 two-hundredths (0.02) inch clearance, and the mandrel dimensions shall be checked by the **Owner**, using this proving ring, before use by the **Contractor**.

3. The **Contractor** shall excavate and install properly any section of pipe not passing this test and re-test until results are satisfactory.

4. 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.

5. Closed Circuit Television Inspection: The **Owner** shall 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 Pipeline Assessment and Certification Program (PACP) requirements. Prior to Final Acceptance the **Owner** shall be provided with one copy of the TV inspection report CD-ROMs, and USB 2 flash drive 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.

3.02 JOINT TESTING PROCEDURES

A. 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 shall 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 shall have failed the test.

1. All test monitoring shall be above ground and in a location to allow for simultaneous and continuous observation by the **Owner**. The void pressure data shall be transmitted electronically from the void to the monitoring equipment.

2. Prior to starting the sanitary sewer joint testing, a two (2) part control test shall be performed as follows:

    a. 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 **Owner**. The demonstration test may be required, by the **Owner**, at any other time during the joint testing Work.

    b. 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 **Owner** who shall have the discretion of modifying the joint test requirements.

3. 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

3.03 MANHOLE TESTING METHODS

A. 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.

B. Manholes:

1. Prior to testing manholes for water tightness, all lift holes 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.

2. Vacuum Tests: The manhole, after proper preparation as noted above, shall be vacuum tested prior to or after backfilling.

   a. 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 forty (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.

b. If tested after backfill, the procedure shall be modified per NPCA guidelines (see www.precast.org).

c. Vacuum testing equipment shall be equal to that as manufactured by P.A. Glazier, Inc.

MINIMUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS AND DEPTHS			
Diameter (feet)	4	5	6
Depth (feet)	**Test Time (seconds)**		
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

C. The **Owner** reserves the right to have third-party consultants perform construction materials testing and assessments to any new manhole.

3.04 ALLOWABLE TESTING LIMITS FOR SANITARY SEWERS

A. Any visible or audible leaks into the sewer that can be located shall be repaired or corrected as directed by the **Owner**.

B. Air leakage tests shall be performed in accordance with the requirements of ASTM C828.

+++ END OF SECTION 02650 +++

SECTION 02711
CHAIN LINK FENCE AND GATES

PART 1 GENERAL

1.01 SCOPE

A. The **Contractor** shall furnish all labor, materials, equipment and incidentals required to furnish and install chain link fence, gates and appurtenances as shown on the Drawings and as specified herein. Chain link fence shall be of the type indicated as follows:

1. Zinc-coated galvanized steel fence fabric with zinc-coated galvanized steel posts, rails, caps, hardware and fittings.

B. Fencing and gates shall be installed in the locations as shown on the Drawings or as directed by the **Owner**, in complete conformity with the manufacturer's written recommendations and as specified herein.

C. The **Contractor** shall also furnish all labor, materials, equipment and miscellaneous items as necessary for the removal and re-installation of existing chain link fence and gates as required for construction of the project.

D. Security fencing for the **Contractor** is at **Contractor's** option and is not included as part of the work specified in this Section.

1.02 SUBMITTALS

A. 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 product data.

2. Derailed shop drawings of the fence and gate layout, including installation details of the fencing, posts, gates, hardware and accessories.

1.03 DELIVERY AND HANDLING

A. Deliver materials with the manufacturer's tags and labels intact.

B. Handle and store materials in such a manner that will avoid damage.

1.04 TRANSPORTATION AND HANDLING

A. Provide transportation and handling in accordance with the requirements of **Section 01610 – Transportation and Handling** of these Specifications.

1.05 QUALITY ASSURANCE

A. 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 Drawings or specified herein.

1. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

2. ASTM A121 – Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

3. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric

6. ASTM A510 – Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

7. ASTM A653 – Standard Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

8. ASTM A824 – Standard Specification for Metallic Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence

9. ASTM A1011 – 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.

10. ASTM F567 – Standard Practice for Installation of Chain-Link Fence

11. ASTM F626 – Standard Specification for Fence Fittings

12. ASTM F900 – Standard Specification for Industrial and Commercial Swing Gates

13. ASTM F934 – Standard Specification for Standard Colors for Polymer-Coated Chain-Link Fence Materials

14. ASTM F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

B. Chain Link Fence Manufacturers Institute (CLFMI): CLFMI Publication, "Standards for Chain Link Fence Installation".

C. Federal Specifications:

1. RR-F-191/2C – Fencing, Wire and Post, Metal (Chain Link Fence Gates) (Detail Specification)

2. RR-F-191/4C – Wire and Post, Metal (Chain Link Fence Accessories) (Detail Specification)

D. The chain link fence and gates shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

E. Manufacturer shall provide written certification that the material provided under this Specification has been amply designed and is a suitable application for these service conditions.

1.06 WARRANTY

A. Provide a warranty against defective materials and workmanship in accordance with the requirements of the General Requirements of the Contract Documents.

PART 2 PRODUCTS

2.01 GENERAL

A. Fencing shall include fabric, covering, framework, barbed wire and supporting arms, concrete footings, gates, hardware and all appurtenances and accessories required for a complete installation.

B. Height of fence shall be six (6) feet.

2.02 MATERIALS

A. Chain Link Fence Fabric

1. Zinc Coated Steel Fence Fabric: Fabric shall be 9 gage wire, woven to 2-inch diamonds and shall be galvanized in accordance with ASTM A392, Type II, Class 2, 2.0 ounces per square foot.

2. Selvages: Selvages shall be twisted and barbed at top and bottom when barbed wire is used; knuckled at both selvages when barbed wire is not used; unless otherwise indicated.

B. Pipe Framework for Zinc Coated Steel Fabric: Posts and rails shall be standard weight galvanized steel pipe conforming to ASTM F1083. Sizes and weights shall be as follows:

1. End and corner posts shall be 4-inches outside diameter galvanized pipe weighing not less than 9.1 pounds per linear foot

2. Line Post: Line posts shall be 2.375-inches outside diameter galvanized pipe weighing not less than 3.65 pounds per linear foot.

3. Rails and braces shall be 1.660-inches outside diameter galvanized pipe weighing not less than 2.27 pounds per linear foot. Posts shall include galvanized bolted fittings to properly secure rails and braces to posts.

C. Tension Wire: Tension wire for top and bottom edge support of fence fabric shall be No. 7 gage steel zinc-coated marcelled tension wire conforming to ASTM A824, Type II with a minimum tensile strength of 80,000 psi.

D. Post Caps and Fittings

1. Post caps and fittings shall be manufacturer's standard, pressed steel or malleable iron post caps, fittings and accessories, meeting the requirements of ASTM F626 and Federal Specification RR-F-191/4C, galvanized for zinc coated steel fencing.

2. Post caps shall be designed to fit securely over the posts to exclude water and to carry the top rail and extension arms, where indicated.

3. All other required fittings and hardware shall be provided to fasten to the pipe posts or concrete in the manner indicated.

E. Truss Rods: Truss rods shall be alloy steel rods conforming to ASTM A510, with a minimum tensile strength of 80,000 psi and a minimum diameter of 5/8-inch. Provide rods with threaded ends and self-tightening galvanized turnbuckles and anchor plates. Secure anchor plates to posts and gate frames by welding.

F. Stretcher Bars: Provide one-piece lengths equal to the full fabric height with a minimum cross section of ¼-inch by ¾-inch. Provide one stretcher bar for each gate and end post and two for each corner and pull post.

G. Stretcher Bar Bands: Provide galvanized heavy pressed steel or malleable iron bands with a minimum cross section of 1/8-inch by ¾-inch, spaced not more than 15-inches on center, to secure stretcher bars to end, corner, pull and gate posts.

H. Accessories

1. Provide miscellaneous materials and accessories, including nuts and bolts, clips, tie wires (9 gage), anchors and fasteners as required for a complete installation. All items shall be galvanized in accordance with ASTM A123 or ASTM A153 as applicable.

I. Barbed Wire Extension Arms

1. Barbed wire extension arms shall be pressed steel conforming to ASTM A653, hot-dip galvanized after fabrication, complete with provision for anchorage to end, corner or pull posts and for attaching three rows of barbed wire to each arm.

2. Arms shall be 45 degree angle or vertical as shown on the Drawings, for three strands of barbed wire. Arms shall be integral with post top weather cap. Intermediate arms shall have holes for passage of top tension wire.

3. Arms shall be capable of withstanding 300 pounds downward pull at outermost end of arm without failure.

J. Barbed Wire: Barbed wire shall be double strand 12 ½ gage steel wire, with 14 gage barbs in a 4-point pattern on 5-inch centers. Wire shall conform to ASTM A121, Type Z (galvanized).

K. Gates: Gates shall be swinging type or sliding type as shown on the Drawings, furnished complete with all hardware and accessories as required for a complete installation.

1. Gate Frames: Gate frames shall be fabricated from zinc-coated steel pipe

members to match zinc-coated fencing having a minimum outside dimension of 1.90-inches and weighing not less than 2.72 pounds per linear foot.

2. Fabrication: Conform to the applicable requirements of ASTM F900, Federal Specification RR-F-191/2C and the following:

   a. Assemble gates by welding or with fittings and rivets for rigid connections. Use same fabric as for fence. Install fabric with stretcher bars at vertical edges and wire ties at top and bottom edges. Attach stretcher bars to gate frames at not more than 15-inches on center. Attach hardware with rivets or by other means that will provide security against removal or breakage.

   b. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories.

   c. Provide diagonal cross bracing consisting of minimum ½-inch diameter adjustable length truss rods on gates where necessary to provide frame rigidly without sag or twist.

3. Gate Hardware

   a. Swinging Gates: Provide gate hinges, latch, stop and keeper for each gate leaf, conforming to the applicable requirements of ASTM F900 and Federal Specification RR-F-191/2C. Provide latch with provision for locking gate with a padlock.

   b. Sliding Gates: Provide manufacturer's standard rubber tired rollers and roller track for floor supported sliding gates. Include intermediate rollers or casters where required to prevent gate sag or deflection. Provide locking device and padlock eyes as part of latch for locking gate with a padlock,

L. Pipe Sleeves: Furnish pipe sleeves for fence post embedment in concrete curbs, barriers and walls. Pipe sleeves shall be fabricated from steel pipe conforming to ASTM A53 and galvanized in accordance with ASTM A123, sized to receive and support fence posts.

2.03 GROUND RODS

A. Ground Rods: Shall be 5/8-inch in diameter and 8 feet in length unless shown otherwise on the Drawings. Ground rods shall be galvanized steel. Galvanizing

shall have a minimum coating of 2 oz. per square foot in accordance with ASTM A153.

2.04 CONCRETE AND GROUT

A. Provide concrete and non shrink grout for footings for fence posts. Concrete shall be 3000 psi and shall be furnished in accordance with the requirements of **Section 03300 - Cast-in-Place Concrete.** Grout shall be as specified in Section 03600, Grout.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fence installation shall not be started before final grading is completed, with finish grade elevations established, unless otherwise directed by the **Engineer**.

B. Install fencing and gates in accordance with the requirements of ASTM F567 and CLFMI Standards for Chain Link Fence Installation. Site fabricate as required to complete the installation.

C. Excavation: Drill holes of diameters and spacings shown, for post footings in firm, undisturbed or compacted soil.

1. If not shown on the Drawings or stated in the Specifications, excavate holes to the minimum diameters as recommended by fence manufacturer.

2. Unless otherwise indicated, excavated hole depths shall be approximately 3-inches lower than the post bottom, with bottom of posts set not less than 36-inches below the surface when in firm, undisturbed soil.

3. If rock is encountered near the surface, drill into rock at least 12-inches for line posts and at least 18-inches for end, pull corner, and gate posts. Drill hole at least 1-inch greater diameter than the largest dimension for the post to be placed. If rock is below soil overburden, drill to full depth required. Penetration into rock need not exceed the minimum depths specified above.

D. Setting Posts: Remove loose and foreign materials from sides and bottoms of holes and moisten soil prior to placing concrete.

1. Center and align posts in holes 3-inches above bottom of excavation.

2. Place concrete around posts in a continuous pour and vibrate or tamp for consolidation. Check each post for vertical and top alignment and hold in

position during placement and finishing operations. Allow concrete to attain at least 75 percent of its minimum 28 day compressive strength, but in no case sooner than five days after placement, before rails, tension wires, barbed wire or fabric is installed. Do not stretch and tension fabric and wires and do not hang gates until the concrete has attained its full design strength.

3. Trowel finish tops of footings and slope or dome to direct water away from posts. Extend footings for gate posts to the underside of bottom hinge. Set keeps, stops, sleeves and other accessories into concrete as required.

4. Keep exposed concrete surfaces moist for at least seven days after placement or cure with membrane curing materials or other acceptable curing methods.

5. Grout-in posts set into sleeved holes, concrete construction or rock excavations with non-shrink Portland cement grout or other acceptable grouting material.

6. Distance between end, pull and corner or angle post assemblies shall not exceed 500 feet for chain link fence in a straight line; and 250 feet for chain link fence in a curved line.

E. Top Rails: Run rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

F. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install tension wires by weaving through the fabric and tying to each post with not less than 6 gage galvanized wire or by securing the wire to the fabric.

H. Chain Link Fabric: 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.

I. Repair damaged coatings in the shop or during field erection by recoating with manufacturer's recommended repair compound, applied per manufacturer's directions.

J. Stretcher Bars: Thread through or clamp to fabric 4-inches on center and secure to posts with metal bands spaced 15-inches on center.

K. Barbed Wire: Install three parallel wires on each extension arm. Pull wire taut and fasten securely to each extension arm. Extension arms shall overhang the outside of the fence at a 45 degree angle. The topmost strand of barbed wire shall be 12-inches above the top of the fabric.

L. Tie Wires: Use U-shaped wire appropriate for the diameter of pipe. Attach pipe and fabric firmly with tie wire ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons or clothing.

M. Fasteners: Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

N. Gates

1. Gate assemblies shall be of the length, height and type as shown on the Drawings.

2. Gate frames shall be welded or with fittings and rivets and shall be coated after assembly. The fabric shall be the same as that used for the fence and shall be rigidly attached to the frames. Frames shall be suitably braced and trussed.

3. Three strands of barbed wire shall be provided on the top of the gate.

4. Swinging gate assemblies shall be furnished with offset hinges to allow the gate to swing open 180 degrees. Provide a minimum of 3 hinges on each gate leaf.

5. Gate assemblies shall be provided with a combination spring latch and plunger rod of approved design for padlocking.

6. Furnish designated gates with galvanized steel stop/hold open device with catch or plunger rod of standard manufacture and approved design.

O. Electrical Ground

1. Wherever a power line carrying more than 600 volts passes over the fence, a ground rod shall be installed. The ground rod shall be installed at the nearest point directly below the point of crossing. Where possible, the rod shall be driven into the ground for a full eight feet of penetration. In rocky soil, the rod may be driven slanted so as to provide 18-inches of cover at the tip.

2. If solid rock is encountered, two ground rods may be installed at the

nearest post on each side of the power line crossing where soil conditions will permit. A length of No. 6 bare copper seven strand wire shall be attached between the fence and the ground rod with suitable clamps.

3.02 REMOVAL AND REPLACEMENT OF EXISTING FENCE AND GATES

A. The **Contractor** shall notify the **Engineer** prior to removal of any existing fence and gates and present to the **Engineer** a plan for maintaining the security of the facility or property in the absence of a complete fencing system.

B. No existing fencing shall be removed unless approved by the **Engineer**.

C. Fence, gates and components that have been removed shall be protected by the **Contractor** until reinstalled. Fence and gates shall be reinstalled when directed by the **Engineer**. Any fence, gates or components that have been damaged by the **Contractor** during removal and storage that are considered unsuitable for reinstallation by the **Engineer** shall be removed from the site and new fence, gates and components shall be furnished and installed by the **Contractor** at no cost to the **Owner**.

D. New fencing, gates and components shall match the existing fence.

3.03 CLEANING

Perform cleaning during installation of the work and upon completion of the work. Remove from site all debris and equipment. Repair all damage resulting from chain link fence system installation.

+ + + END OF SECTION 02711 + + +

SECTION 02920
SITE RESTORATION

PART 1 - GENERAL

1.01 SCOPE

A. This section includes disposition of materials and structures encountered in the Work; ground preparation; mulching; seeding; fence reset; cleanup; and any other similar, incidental, or appurtenant operation that may be necessary to properly complete the Work. **Where these specifications might differ from the SCWA Standards, the Standards shall prevail.**

B. The **Contractor** shall provide all services, labor, materials, and equipment required for all site restoration and related operations necessary or convenient to the **Contractor** for furnishing a complete Work as shown on the Plans or specified in these Specifications.

C. Related Work Specified Elsewhere:

1. Section 02200 - Earthwork
2. Section 02231 - Tree Protection and Trimming
3. Section 02324 - Trenching and Trench Backfilling
4. Section 02485 - Seeding
5. Section 02486 - Sodding
6. Section 02510 - Asphalt Paving
7. Section 02535 - Gravity Flow Sanitary Sewers

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Requirements of the Contract Documents and **Section 01300 - Submittals**. In addition, the following specific information shall be provided:

1. Certificates of inspection as required by government authorities. The **Contractor** shall submit manufacturers' or vendors' certified analysis for soil amendments and fertilizer materials. The **Contractor** shall submit other data substantiating that materials comply with specified requirements.

2. Typewritten instructions recommending procedures to be established by the **Owner** for maintenance of site restoration work for one (1) full year.

3. Seed vendors certified statements for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed for each grass seed species.

4. Proposed planting schedules, indicating dates for each type of planting work during normal seasons for such work in the site of the Work. The **Contractor** shall correlate with specified maintenance periods to provide maintenance from the Date of Substantial Completion. Once accepted, the **Contractor** shall revise dates only as approved in writing, after documentation of reasons for delays.

1.03 QUALITY ASSURANCE

A. 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. ASTM C602 - Standard Specification for Agricultural Liming Materials.

2. Turfgrass Producers International.

B. The **Contractor** shall ship site restoration materials with certificates of inspection required by authorities having jurisdiction. The **Contractor** shall comply with regulations applicable to site restoration materials.

C. If specified site restoration materials are not obtainable, the **Contractor** shall submit proof of non-availability to the **Owner** together with proposal for use of equivalent material.

D. The **Contractor** shall package standard products with manufacturers' certified analysis. For other material, the **Contractor** shall provide analysis by recognized laboratory, in accordance with methods established by the Association of Official Agricultural Chemists, as applicable.

1.04 SAFETY REQUIREMENTS

A. Hazards Control:

1. The **Contractor** shall store volatile wastes in covered metal containers and remove from the site of the Work daily.

2. The **Contractor** shall prevent accumulation of wastes that create hazardous conditions.

3. The **Contractor** shall provide adequate ventilation during use of volatile or noxious substances.

B. The **Contractor** shall conduct cleaning and disposal operations in compliance with local ordinances and environmental laws and regulations.

1. The **Contractor** shall not burn or bury rubbish and waste materials on the site of the Work without prior written permission from the **Owner**.

2. The **Contractor** shall not dispose of volatile wastes such as mineral spirits, oil, or fuel in open drainage ditches or storm or sanitary drains.

1.05 DELIVERY

A. The **Contractor** shall deliver packaged materials in containers showing weight, analysis, and name of manufacturer. The **Contractor** shall protect materials from deterioration during delivery, and while stored at the site of the Work.

1.06 JOB CONDITIONS

A. All bare earth areas within the limit of work shall be grassed, mulched, or covered with other plant material as shown on the Plans. Final restoration of existing lawn areas (i.e. private residences, schools, and parks) shall be sod.

B. On a continuous basis, the **Contractor** shall maintain the site of the Work free from accumulations of waste, debris, and rubbish caused by its operations.

C. At completion of the Work, the **Contractor** shall remove waste materials, rubbish, tools, equipment, machinery, and surplus materials, and clean all sight-exposed surfaces. The **Contractor** shall leave the site of the Work clean and ready for occupancy.

D. The **Contractor** shall proceed with the complete site restoration work as rapidly as portions of the site of the Work become available, working within seasonal limitations for each kind of site restoration work required. The **Contractor** shall not be allowed to postpone cleanup and seeding until the end of the Work.

E. The **Contractor** shall determine the locations of underground utilities and perform Work in a manner that shall avoid possible damage. The **Contractor** shall hand excavate, as required. The **Contractor** shall maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

F. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, the **Contractor** shall notify the **Owner** before planting.

G. The **Contractor** shall install materials during normal planting seasons for each type of site restoration work.

H. The **Contractor** shall plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to the **Owner**. If planting of trees and shrubs occurs after lawn work, the **Contractor** shall protect lawn areas and promptly repair damage to lawns resulting from planting operations.

I. The **Contractor** may, at its option, employ additional measures (other than those specified) to prevent loss of, or damage to the Work resulting from the effects of wind and/or water. No additional compensation shall be made for the employment of such additional measures.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. Topsoil for site restoration may not be available at the site of the Work in sufficient quantities and shall be furnished as specified.

B. New topsoil shall be fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay, lumps, brush, weeds, and other litter, and free of roots, stumps, stones, and other extraneous or toxic matter harmful to plant growth.

C. The **Contractor** shall obtain topsoil from local sources or from areas having similar soil characteristics to that found at the site of the Work. The **Contractor** shall obtain topsoil only from naturally, well-drained sites where topsoil occurs in depths of not less than four (4) inches. The **Contractor** shall not obtain topsoil from bogs or marshes.

2.02 MATERIALS

A. Grass seed shall meet the requirements of the State of Georgia Seed Laws and Rules and Regulations except that the requirements as to purity, germination, and noxious weeds shall be specified in this section. See **Section 02485 - Seeding.**

1. Quality: Grass seed quality shall be as shown in the Table below:

Grass Seed Quality			
Seed	**Purity Min. %**	**Germination Min %**	**Noxious Weed Max. Per Lb.**

Sahara Bermuda Grass	98	90	None
Annual Rye Grass	98	90	None
Rebel II Turf Type Fescue	85	85	None

2. Seed shall be approved by the **Owner** before sowing. Seed shall have been tested by the Georgia Department of Agriculture, and no seed shall be acceptable with a date of test more than six (6) months prior to the date of sowing. Such testing, however, shall not relieve the **Contractor** from responsibility for furnishing and sowing seed that meet the requirements of these Specifications at the time of sowing seed. When required by the **Owner**, samples of seed shall be furnished by the **Contractor** early enough before seeding to permit further testing before the seed is used. When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the **Contractor** may choose to increase the rate of seeding to obtain the minimum pure live seed content specified, provided that such an increase in seeding rates does not cause the quantity of noxious weed seed per square yard to exceed the quantity that would be allowable at the regular rate of seeding.

3. Seed that has become wet, moldy, or otherwise damaged shall not be acceptable.

B. All fertilizer shall be of the grades specified and shall meet the requirements of the State Plant Food Act in effect thirty (30) days prior to the taking of bids. It shall be uniform in composition, dry and free flowing and shall be delivered to the site of the Work in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Any fertilizer that is caked or otherwise damaged, making it unsuitable for use, shall not be accepted.

C. Mulch shall meet the following requirements:

1. Be acceptable to the **Owner**.

2. Be of such consistency that, when properly loosened, it can be distributed in a uniform application.

3. Be capable of producing the desired results.

4. Meet State and Federal Quarantine Restrictions pertaining to fire ants, Japanese beetles, and white fringed beetles.

5. Shall have a moisture content of twelve (12) percent or less.

6. Contain no excessive amounts of noxious weed seeds.

7. All materials shall carry the following certification: “This material is certified as free for movement under the State and Federal Imported Fire Ant, Japanese Beetle, and White Fringed Beetle Quarantines.”

8. Mulch shall be threshed rye, oat straw, wheat straw, or Bermuda grass hay.

D. Agricultural lime shall be a pulverized limestone having the following properties:

1. Total carbonate, not less than eighty five (85) percent.

2. Passing ten (10) mesh screen at least one hundred (100) percent.

3. Passing one hundred (100) mesh screen at least twenty five (25) percent.

E. **Hydro mulch**: Wood cellulose fiber containing no germination, inhibiting, or growth inhibiting agent. Characteristics shall be as follows:

1. Percent moisture content: Nine (9.0%) percent ± 3.0 percent.

2. Percent organic matter: Nine and two-tenths (9.2%) percent ± 0.8 percent.

3. Percent ash content: One and eight-hundredths (1.08%) percent ± 0.2 percent.

4. pH: four and eight tenths (4.8) (± 0.5).

5. Water holding capacity: one thousand one hundred fifty (1150) grams water/ one hundred (100) grams fiber minimum.

F. **Sod**: Sod shall meet the requirements of Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, Section 700 and 890, latest edition. **See Section 02486 - Sodding.**

2.03 GRASSING

A. Grass seed shall be as specified on the table below depending on the season or as instructed by the **Owner**. See **Section 02485 – Seeding** for reference.

B. Disturbed Area Stabilization (Temporary Seeding) shall be planted according to **Section 02125 – Temporary and Permanent Erosion and Sediment Control**

PART 3 - EXECUTION

3.01 DISPOSITION OF MATERIALS AND STRUCTURES ENCOUNTERED IN THE WORK

A. Existing materials or structures that may be encountered (within the lines, grades, or trenching sections established for completion of the Work), if unsuitable or unacceptable to the **Owner** for use in the Work, and for which the disposition is not otherwise specified, shall either be disposed of by the **Contractor** or shall remain the property of the **Owner** as further provided in this section.

B. At the option of the **Owner**, any existing materials or structures of "value" encountered in the Work shall remain the property of the **Owner**. The term "value" will be defined by the **Owner**.

C. Any existing materials or structures encountered in the Work and determined not to be of "value" by the **Owner**, shall be disposed of by the **Contractor**, in an approved manner, except as otherwise specified in **Section 02200 – Earthwork**.

3.02 GROUND PREPARATION

A. All ground to be sodded, sprigged, overseeded, or grassed shall be prepared by plowing, disking, and harrowing to a depth or not less than six (6) inches. After plowing, topsoil shall be spread on the prepared area to a depth of four (4) inches and smoothed to a uniform depth. The finished surfaces shall present a smooth, uniform, loose, well broken soil. All large clods, boulders, stumps, large roots, roots, debris, and other particles two (2) inches in diameter or greater and which will interfere with the Work shall be removed from the site of the Work.

B. Lime shall be uniformly spread over the area to be planted or sowed at the rate of two thousand (2,000) pounds per acre. Commercial grade five (5) percent nitrogen-ten percent phosphorus – ten percent potassium (5-10-10) fertilizer or approved equal shall also be uniformly spread over the area at the rate of one thousand five hundred (1,500) pounds per acre or as recommended by the manufacturer. The fertilizer and the lime shall then be thoroughly mixed into the top six (6) inches of the soil. All surface areas distorted by mixing of line and fertilizer into the soil shall be restored to the proper line and grade before any more work is done on the area.

3.03 MULCHING

A. The quantity of mulch to be applied shall be that required to evenly cover the ground to a depth of at least three (3) quarters of an inch and not more than one and one-half (1½) inches, according to the texture and moisture content of the mulch material. It is intended that mulch allow some sunlight to penetrate

and air to circulate while at the same time shading the ground and conserving soil moisture.

B. **Mulch**: Mulch shall be uniformly applied manually or with special blower equipment. When a blower is used, baled material shall be thoroughly loosened before it is fed into the machine so as to obtain a uniform coating of mulch and to prevent placement of unbroken clumps. After initial distribution, thick clumps that are dense enough to prevent new grass from emerging shall be loosened and redistributed. Mulch shall not be applied on windy days when the velocity of the wind is sufficient to prevent uniform distribution of mulch.

C. **Hydro mulch**: If Hydro mulch is used, it shall be mixed to provide equivalent quantities of fertilizer and seed as specified in this section.

3.04 SEEDING

A. Seed shall be uniformly sown at the rates specified, by the use of approved mechanical seed drills, rotary hand seeders, or other type of equipment that shall produce a uniform application of the seed. The **Contractor** shall not distribute seed by hand.

B. In order to obtain an even distribution, seeds shall be sown separately except that seeds of approximately the same size may be mixed and sown together. No sowing shall be done during windy weather that prevents even distribution of the seeds, when the prepared surface is crusted, frozen, wet, or otherwise in non-tillable condition.

C. Immediately after seeding, all areas shall be rolled.

D. Watering: After seeding of areas are complete, watering shall be continued daily as long as necessary to promote a rapid growth except that no water shall be applied between the hours of 10 A.M. and 4 P.M. to prevent “crushing over” from the sun.

E. First Application of Nitrogen (All areas): The first application of nitrogen shall be made on all areas when there is evidence that a satisfactory stand of grass will be obtained. For seeded areas, the young grass shall have reached a height of at least one (1) inch. At this time, nitrate of soda, or other approved commercial fertilizer high in nitrogen content shall be applied at a rate sufficient to furnish seventy (70) pounds of nitrogen per acre. No fertilizer shall be applied to unsatisfactory areas that will have to be replanted.

F. Second Application of Nitrogen (all areas): A second application of nitrogen shall be made thirty (30) days after sufficient moisture has been applied to make the first application available for plant growth. Second application shall also furnish seventy (70) pounds nitrogen per acre.

G. Maintenance: The **Contractor** shall provide all maintenance necessary to keep all seeded and turf areas in a healthy, satisfactory, and weed-free condition until the Work is finally accepted. This includes repairing washed-out areas, and correctly applying additional seed, fertilizer, and water if they are needed.

H. Satisfactory Stand Defined:

1. A stand of grass shall be considered satisfactory by the **Owner** only if there is full cover over the seeded area with perennial grass that is alive and growing, leaving no bare spots larger than one (1) square foot or the total of all bare spots within a given area shall constitute no more than one one-hundredth (1/100) of the total area.

2. If it is necessary to repeat any or all of the work necessary to produce a viable stand of perennial grass, including repairing washed-out areas, soil preparation, re-fertilizing, liming, re-seeding, sprigging, watering, or mulching, the **Contractor** shall repeat these operations until satisfactory stand is obtained and approved by the **Owner**.

I. The **Contractor** shall remove all stumps, fallen trees, uprooted trees, dead trees, and debris from the edge of the right-of-way.

3.05 SOD

A. Furnish and install sod in all lawn areas or as designated by the **Owner**.

1. Use only Common Bermudagrass (Cynodon dactylon) or one of the following Bermudagrass varieties:

   a. Tifway 419

   b. Tifway II Hybrid

   c. Tift 94

   d. Tifton 10

   e. Midlawn

   f. Midiron

   g. GN-1 Hybrid

   h. Vermont

2. No dwarf Bermuda types shall be used. Sod shall be nursery-grown and accompanied with a Georgia Department of Agriculture Live Plant License

Certificate or Stamp. Sod shall consist of live, dense, well-rooted material free of weeds and insects as described by the Georgia Live Plant Act.

3. Place sod by hand or by mechanical means so that joints are tightly abutted with no overlaps or gaps. Use soil to fill cracks between sod pieces, but do not smother the grass.

4. Once sod is placed and staked as necessary, tamp, or roll it using adequate equipment to provide good contact with soil.

5. Use caution to prevent tearing or displacement of sod during this process. Leave the finished surface of sodded areas smooth and uniform.

B. After the sod has been placed and rolled or tamped, water it to promote satisfactory growth. Additional watering will be needed in the absence of rainfall and during the hot, dry summer months. Water may be applied by Hydro Seeder, Water Truck or by other means approved by the **Owner**.

C. Sod will be inspected by the **Owner** at the end of the first spring after installation and at the time of Final Inspection. Replace any sod that is not live and growing. Any cost for replacing any unacceptable sod shall be at the **Contractor**'s expense.

D. Apply nitrogen at approximately fifty (50) pounds/acre when specified by the **Owner** after plants have grown to two (2) inches high. One application is mandatory and shall be applied before Final Acceptance. Apply nitrogen with mechanical hand spreaders or other approved spreaders capable of uniformly covering the grassed areas. Do not apply nitrogen on windy days or when foliage is damp. Do not apply nitrogen between October 15 and March 15.

3.06 FENCE RESET

A. Should the construction of the sewer require or result in removal or damage to an existing fence, the **Contractor** shall replace the fence in kind to the satisfaction of the fence owner.

3.07 CLEANUP

A. During site restoration work, the **Contractor** shall keep pavements clean and the site of the Work in an orderly condition.

B. The **Contractor** shall protect site restoration work and materials from damage due to site restoration operations, operations by other contractors, and trades and trespassers. The **Contractor** shall maintain protection during installation and maintenance periods. The **Contractor** shall treat, repair, or replace damaged site restoration work as directed by the **Owner**.

C. Throughout the progress of the Work, the **Contractor** shall keep the construction area, including storage areas used by the **Contractor**, free from accumulations of waste material or rubbish, and shall keep its materials and equipment in a neat and orderly manner. Immediately upon completion of any section of the Work and before payment therefore has been made, the **Contractor** shall remove from the site of the Work all construction equipment, temporary structures, and debris, and shall restore the site of the Work to a neat, workmanlike condition; the **Contractor** shall not remove barricades and warning and direction signs until directed by the **Owner**. The **Contractor** shall not postpone cleanup and seeding until the end of the Work. Waste materials shall be disposed of at locations satisfactory to the **Owner** or affected regulatory agencies.

D. After completion of all Work contemplated under the Contract and before final payment has been made, the **Contractor** shall make a final cleanup of each separate part of the Work; shall restore all surfaces to a neat and orderly condition; and shall remove all construction equipment, tools, and supplies.

3.08 INSPECTION AND ACCEPTANCE

A. When site restoration work is completed, including maintenance, the **Owner** will, upon request, make an inspection to determine acceptability.

B. Where inspected site restoration work does not comply with the requirements of the **Owner**, the **Contractor** shall replace rejected work and continue specified maintenance until reinspected by the **Owner** and found to be acceptable. The **Contractor** shall remove rejected plants and materials promptly from the site of the Work.

+++ END OF SECTION 02920 +++

SECTION 03100
CONCRETE FORMWORK

PART 1 – GENERAL

1.01 SCOPE

A. Design, detail, furnish, utilize, and install concrete formwork as shown and as needed for Work shown on the Drawings and as specified herein. Design and detail components, where specified herein.

B. Furnish labor, material, equipment, and incidental items necessary to complete Work.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):

a. 117, Specification for Tolerances for Concrete Construction and Materials.

b. 301, Specifications for Concrete Construction.

c. 347, Guide to Formwork for Concrete.

2. NSF International (NSF):

a. NSF 61, Drinking Water System Components – Health Effects.

1.03 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold that supports the concrete while the concrete is setting and gaining sufficient strength to be self-supported.

B. Formwork: The total system supporting freshly placed concrete, including the mold or sheathing in contact with the concrete, as well as supporting members, hardware, and required bracing.

C. Concrete form-facing surface classifications are defined as follows:

1. Class A: Surfaces prominently exposed to view where appearance is of special importance.

2. Class B: Surfaces intended coarse-textured surfaces to receive plaster, stucco, or wainscoting.

3. Class C: Surfaces that will be permanently exposed and other finish requirements are not specified.

4. Class D: Surfaces where roughness is not objectionable and are permanently concealed.

1.04 SUBMITTALS

A. Formwork Shop Drawings: Prepared in accordance with ACI 301 by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Design and engineering of formwork are **Contractor's** responsibility.

B. Submit for approval copies of manufacturer's data and installation instructions for proprietary materials, including form coatings and releasing agents, manufactured form systems, ties, and accessories.

C. Layout drawings for wall control joints, wall weakened plane joints, and wall expansion joints.

D. For environmental structures, submit certificates of compliance with NSF 61 for all applicable formwork products.

1.05 QUALITY ASSURANCE

A. Formwork shall comply with ANSI A10.9 and OSHA Construction Standards, Part 1926, Subpart Q, Concrete, Concrete Forms, and Shoring. In addition, the form designs shall meet the requirements of ACI 301.

B. Notify the Engineer a minimum of 48 hours before closure of forms that would hinder the subsequent inspection to enable the Engineer to inspect the work.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Preparation for Shipment:

1. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage and facilitate identification and final assembly in field.

2. Insofar as is practical, factory assemble items provided hereunder.

D. Storage and Handling:

1. In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 – PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

B. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."

C. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing supports.

D. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:

1. Wind Loads: As indicated on Drawings.

a. Horizontal Deflection Limit: Not more than 1/240 of the wall height.

2.02 FORM-FACING MATERIALS

A. Unless otherwise shown or specified, construct formwork for concrete surfaces exposed to view in the finished structure, with plywood, metal, metal-framed plywood-faced or other panel type materials acceptable to Engineer, to provide continuous, straight, smooth as-cast surfaces.

B. Forms for Exposed Finish Concrete: (Smooth Finish)

1. Unless otherwise shown or specified, construct formwork for concrete surfaces exposed to view in the finished structure, with plywood, metal, metal-framed plywood-faced or other panel type materials acceptable to Engineer, to provide continuous, straight, smooth as-cast surfaces.

2. Furnish in largest practical sizes to minimize number of joints and to

conform to joint system shown or specified. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

3. Acceptable Materials:

   a. Plywood, metal, or other approved materials.

   b. Exterior grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

      1) APA HDO (high-density overlay).

      2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.

      3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.

      4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

C. Forms for Unexposed Finish Concrete: (Rough Finish)

   1. Form concrete surfaces that will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material.

   2. Provide lumber that is dressed on at least 2 edges and 1 side for tight fit.

D. Forms for Cylindrical Columns, Pedestals, and Supports:

   1. Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surface finishes with gradual or abrupt irregularities not exceeding specified formwork surface class.

   2. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with straight end forms.

F. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support the weight of plastic concrete and other superimposed loads.

2.03 FORMWORK ACCESSORIES

A. Form Ties:

1. Provide factory-fabricated, removable or snap off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete, prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used for tying Forms will be subject to approval of the Engineer.

2. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1 inch from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a hole no larger than 1-inch diameter in the concrete surface.

3. Ties for exterior walls and walls subject to hydrostatic pressure shall have waterstops that are one of the following:

   a. Integral steel waterstop at least 0.103-inch thick and 0.625-inch diameter and continuously welded to tie.

   b. Neoprene waterstop 3/16-inch thick and 15/16-inch diameter whose center hole is one half diameter of tie, or molded plastic waterstop of comparable size.

4. Design tie to prevent rotation or disturbance of embedded tie (portion to remain) during removal of ends and to prevent water leaking along tie.

G. Form Release Agents:

1. Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs).

2. Form release agent shall not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

3. For steel form-facing materials, use release agent with rust inhibitor.

H. Chamfers:

1. Provide 1 inch by 1 inch chamfer on exterior corners and edges of permanently exposed concrete.

2. Approved materials included wood, metal, PVC, or rubber strips.

I. Rustication Strips:

1. Wood, metal, PVC, or rubber strips kerfed for ease of form removal.

PART 3 – EXECUTION

3.01 DESIGN OF FORMWORK

A. Formwork shall be in accordance with ACI 301 and as follows:

1. Design, erect, shore, support, brace, and maintain formwork to support vertical, lateral, static, dynamic, and construction loads that might be applied until concrete structure can support such loads.

2. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position, within tolerance limits of ACI 117.

3. Construct forms to sizes, shapes, lines, and dimensions shown on the drawings and to obtain alignment, location, grades, level, and plumb work in finished structures. Provide openings, offsets, keyways, recesses, moldings, blocking, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes.

4. Solidly butt joints and provide backup at joints to prevent cement and mortar pastes from leaking.

5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crus plates or wrecking plates where stripping may damage cast concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal. Do not use rust-stained steel form facing material.

6. Provide openings and box-outs for chases, recesses, or other openings required by other trades required to complete the Work.

7. Install all the items (sleeves, inserts, hangers, anchors, etc.) to be supported by the formwork as required by the work.

8. 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.

9. The use of reinforcing steel, partially embedded in concrete, as toe pins or

form spacers is prohibited.

B. 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, recesses, and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

6. Chamfer exposed corners and edges.

C. Corner Treatment:

1. Form exposed corners of beams, walls, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown. Except as specified below for re-entrant or internal corners, exposed corners shall be chamfered.

2. Form chamfers with 1 inch by 1 inch strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in direction.

3. Re-entrant or internal corners and unexposed corners may be formed square.

D. Joints:

1. See Specification **Section 03150 - Concrete Joints & Accessories** and Drawings for treatment of joints. Locate as shown and specified.

E. Cleaning and Tightening:

1. Thoroughly clean forms and adjacent surfaces to receive concrete.

Remove chips, wood, sawdust, dirt, or other debris just before concrete is to be placed.

2. Re-tighten forms immediately after concrete placement as required to-eliminate mortar leaks.

3.02 PREPARING FORM SURFACES

A. Coat contact surfaces of forms with non-residual, low-VOC, form release agent before placing reinforcement. For form liners, use a form release coating recommended by the liner manufacturer.

B. 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.

C. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

D. 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.

3.03 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into the formwork, anchorage devices and other embedded items, shown specified or required by other Sections. Use necessary setting drawings, diagrams, instructions, and directions.

B. All embeds should be supported, plumbed, and carefully taped or covered to prohibit the infiltration of concrete during the pour.

C. Coat any aluminum or reactive metal inserts, with non-reactive coating to isolate the metal surfaces.

D. Edge Forms and Screed Strips for Slabs and Sidewalks:

1. 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.

2. The screeds may not be tack welded to the rebar embeds, or structural steel.

E. Clean embedded items immediately prior to concrete placement.

3.04 FIELD QUALITY CONTROL

A. Before concrete placement, the Engineer shall inspect all formwork. No concrete shall be poured without Engineer's approval.

B. Before concrete placement, **Contractor** shall check the formwork, including lines, ties, tie cone, and form coatings. **Contractor** shall make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

C. 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.

D. 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.

3.05 REMOVAL OF FORMS

A. Remove forms and falsework in a manner that will prevent damage to the concrete and not impair the safety of the structure.

B. Do not use pinch bars or similar tools to pry against concrete surfaces.

C. Do not remove forms until concrete has aged at not less than 50 degrees Fahrenheit for the durations 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.

D. Elevated slabs and beams shall have attained at least 70 percent of the specified 28-day strength before form removal. Concrete shall also have sufficient strength to safely support its own weight and construction loads. Determine concrete strength for form removal in conformance with ACI 301.

E. Reshore elevated concrete elements immediately upon form removal. Shoring shall remain in place until the concrete has attained the specified 28-day design strength.

F. Maintain shoring of elevated concrete elements which support subsequent construction when the subsequent construction loads exceed the design live

load of the elements.

3.06 REUSE OF FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form releasing agent for each reuse.

B. 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.

C. Metal surfaced forms must have a smooth even surface without plate patches.

3.07 ACCEPTABLE TOLERANCES

A. Variation from plumb in the lines and surfaces of columns, piers, and walls:

1. In any 10 Feet of Height:

a. For Walls: +/-1/2 inch

b. For All Other Elements: +/-1/4 inch

2. Maximum for the Entire Height: +/-1 inch

B. Vertical deviation permitted from floor level or from the grades shown on the Drawings:

1. Tops of slabs-on-ground: +/-3/4 inch

2. Tops of suspended slabs, before removal of shoring: +/-3/4 inch

3. Lintels, sills, parapets, horizontal grooves, and other exposed lines of concrete: +/-1/2 inch

4. Tops of walls: +/-3/4 inch

C. Horizontal deviation permitted from the linear building lines shown on the Drawings:

1. Vertical edges of columns, piers, and walls measured at the top of the element: +/-1 inch.

2. Edges of all openings: +/-1/2 inch

3. Sawcut, expansion, and construction joints: +/-3/4 inch

D. Variation in the sizes and location of sleeves for pipes and conduits, floor openings and wall openings: +1/4 inch, -0 inch

E. Deviation permitted from the cross-sectional dimensions shown on the Drawings:

1. Thickness of suspended slabs: +0 inch, -1/4 inch

2. Thickness of slabs-on-ground: +1 inch, -3/8 inch

3. Thickness of formed elements:

a. 12 inch or less: +3/8 inch, -1/4 inch

b. Between 12 inch and 36 inch: +1/2 inch, -1/4 inch

c. 36 inch or more: +1 inch, -3/4 inch

4. Thickness of unformed elements cast against soil: +3 inch, -1/2 inch

F. Deviations permitted for foundations:

1. Horizontal deviation from location shown on Drawings: +/-2% of the foundation width in the direction of misplacement but not more than +/-2 inches.

2. Vertical deviation from top elevation shown on Drawings: +1/2, -2 inches.

3. Thickness: +5% of thickness shown on Drawings; no decrease is permitted.

G. Deviations permitted for stairs:

1. In a Flight of Stairs:

a. Rise: +/-1/4 inch.
b. Tread: +/-1/4 inch

2. In Consecutive Steps:

a. Rise: +/-3/16 inch

b. Tread: +/3/16 inch

H. Abrupt irregularities for all formed surfaces shall measure +/-1 inch of the irregularity.

I. Gradual irregularities for all formed surfaces shall be measured by determining the gap between concrete surface and the edge of a 5'-0" straightedge and not exceeding:

1. +1/8 inch for Class A surfaces.

2. +1/4 inch for Class B surfaces.

3. +1/2 inch for Class C surfaces.

4. +1 inch for Class D surfaces.

J. Maximum permitted deviations from plane for slopes of formed surfaces:

1. Vertical deviations from plane shall be measured to not exceed the following amounts when measure with a 10 ft straightedge:

a. Visible surfaces: +/-0.2%

b. Concealed surfaces: +/-0.4%

+++ END OF SECTION 03100 +++

SECTION 03150
CONCRETE JOINTS AND ACCESSORIES

PART 1 – GENERAL

1.01 SCOPE

A. Design, detail, furnish, utilize, and install concrete joints and accessories as shown and as needed for Work shown on the Drawings and as specified herein. Design and detail components, where specified herein.

B. Furnish labor, material, equipment, and incidental items necessary to complete Work.

C. The types of concrete joints and accessories covered in this Section:

1. Construction Joints

2. Expansion Joints and Fillers

3. Waterstops

4. Joint Sealants

D. All joints subject to hydrostatic pressure shall be provided with continuous waterstop.

1.02 SUBMITTALS

A. Submit for approval copies of manufacturer's data and installation instructions for proprietary materials, including waterstops, backer rod materials, joint sealants, and other accessories.

B. Layout drawings for wall control joints, wall weakened plane joints, and wall expansion joints.

C. For environmental structures, submit certificates of compliance with NSF 61 for all applicable formwork products.

D. Details of waterstop splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.

E. Samples of PVC waterstop, joint, and fabricated cross of each size, shape, and fitting of waterstop if requested by the Engineer.

F. Letter stating compatibility between liquids being contained and materials

used for waterstops and joint fillers.

1.03 QUALITY ASSURANCE

A. Notify the Engineer a minimum of 48 hours before closure of forms that would hinder the subsequent inspection to enable the Engineer to inspect the work.

B. All manufactured items shall be installed in accordance with the manufacturer's instructions.

C. Construction and expansion joints shall not be added or relocated without the approval of the Engineer.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Preparation for Shipment:

1. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage and facilitate identification and final assembly in field.

2. Insofar as is practical, factory assemble items provided hereunder.

B. Storage and Handling:

1. In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 – PRODUCTS

2.01 PVC WATERSTOP

A. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.

B. Profile: Ribbed with center bulb with factory-installed metal eyelets for embedding in concrete to prevent passage of fluids through joints.

C. Dimensions: 6 inches by 3/8 inch thick.

D. Specific Gravity: Approximately 1.37.

E. Shore Durometer Type A Hardness: Approximately 80.

F. Performance Requirements: COE Specification CRD C 572.

G. Type Required at Construction Joints for New Concrete to Existing Concrete:

1. Retrofit, tee shaped waterstop with vertical leg centered in new concrete wall or slab.

2. Vertical leg shall be a minimum of 6 inches wide with parallel longitudinal ribs or protrusions on each side of strip center.

3. Horizontal legs shall be 4-1/2 inches wide each (9 inches wide total) with batten bar each side of vertical leg anchored to existing concrete.

4. Batten bars shall be continuous, stainless steel bars with stainless steel anchors at 12 inches on center spacing.

5. Horizontal leg of waterstop shall be continuously adhered to existing concrete with adhesive epoxy per manufacturer's recommendations.

H. Corrugated or tapered type waterstops are not acceptable.

I. Thickness shall be constant from center bulb (or center of waterstop), to outside stop edge.

J. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

2.02 HYDROPHILIC WATERSTOP

A. Manufactured rectangular or trapezoidal strips with adhesive to bond to concrete surfaces.

B. For use at construction joints only, where new concrete is placed against existing concrete and as shown on Drawings.

C. Material shall be a non-bentonite hydrophilic rubber compound.

D. Dimensions: 3/4 by 1 inch.

E. Adhesive products shall be made by same manufacturer as hydrophilic waterstop product.

2.03 PREMOLDED JOINT FILLER

A. Bituminous Type: ASTM D1751 - Composed of cellular fibers securely bonded together and uniformly saturated with bituminous materials and non-

extruding.

B. Sponge Rubber Type: Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum.

2.04 JOINT SEALANT

A. Materials shall be tow component, polyurethane meeting ASTM C-920.

B. Materials shall have +/- 50% movement.

C. Horizontal Joints: Self-leveling product.

D. Vertical and Overhead Joints: Non-sag product.

PART 3 – EXECUTION

3.01 JOINT CONSTRUCTION

A. Construction Joints: Locate and install construction joints so they do not impair the strength or appearance of the structure.

B. Provide wood keyways where shown at construction joints in footings, and walls. Nominal size: 2 inches by 4 inches for members 12-inches thick or less and 2 x 6 for members greater than 12-inches thick.

C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints and lap with reinforcing in the adjacent pour, unless otherwise noted.

D. Locate and form vertical weakened plane joints in walls as indicated on the Drawings. Form weakened plane joints in walls 8-inches thick and less by forming a 1-1/2 inch deep vertical reveal in the interior face of walls. Discontinue or cut 1/2 of the horizontal reinforcing (every other continuous horizontal reinforcing bar) at the weakened plane joint

3.02 WATERSTOP INSTALLATION

A. General:

1. Continuous waterstop (as specified) shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of below-grade structures, unless specifically noted otherwise.

2. Join waterstop at intersections to provide continuous seal.

3. Center waterstop on joint.

4. Secure waterstop in correct position. Tie waterstop to reinforcing steel using grommets, “Hog Rings,” or tie wire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.

5. Repair or replace damaged waterstop.

6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.

7. Joints in Footings and Slabs:

    a. Ensure that space beneath PVC waterstop is completely filled with concrete.

    b. During concrete placement, make visual inspection of waterstop area.

    c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. PVC Waterstop:

1. Install in accordance with manufacturer’s written instructions.

2. Splice in accordance with waterstop manufacturer’s written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees F.

    a. Allow at least 10 minutes before new splice is pulled or strained in any way.

    b. Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.

    c. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.

    d. Field splice permitted only for straight butt welds.

3. Wire looped PVC waterstop may be substituted for PVC waterstop.

C. Hydrophilic Waterstop:

1. Install in accordance with manufacturer's written instructions.

2. Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.

3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.

4. Lap ends of waterstop strip together at splices and corners and join with sealant.

5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.

6. Lap hydrophilic waterstop 2 feet minimum with intersecting PVC waterstops.

3.03 FIELD QUALITY CONTROL

A. Before concrete placement, the Engineer shall inspect all embedded joint items. No concrete shall be poured without Engineer's approval.

B. Before concrete placement, Contractor shall check the waterstops and other embedded joint accessories. Contractor shall make corrections and adjustments to ensure proper size and location of watestops and other embedded joint accessories.

C. During concrete placement Contractor shall check waterstops and related supports to ensure that waterstops are not displaced, and that completed Work shall be within specified tolerances.

D. If Contractor finds that waterstops 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.

+++ END OF SECTION 03150 +++

SECTION 03200
CONCRETE REINFORCING

PART 1 – GENERAL

1.01 SCOPE

A. Detail, furnish and install concrete reinforcement as shown on the Drawings and as specified herein. Design and detail components, where specified herein.

B. Furnish labor, material, equipment, and incidental items necessary to complete Work.

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):

   a. 117, Specification for Tolerances for Concrete Construction and Materials

   b. 301, Specifications for Concrete Construction

   c. 315R, Guide to Presenting Reinforcing Steel Design Details

   d. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary

   e. 350.5, Specifications for Environmental Concrete Structures

   f. MNL-66, ACI Detailing Manual

2. American Society for Testing and Materials International (ASTM):

   a. A184/A184M, Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

d. A706/A706M, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

e. A970/A970M, Standard Specification for Headed Steel Bars for Concrete Reinforcement

f. A1064/A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

3. American Welding Society (AWS):

   a. D1.4/D1.4M, Structural Welding Code – Reinforcing Steel

4. Concrete Reinforcing Steel Institute (CRSI):

   a. Manual of Standard Practice

   b. Reinforcing Bar Detailing

   c. RB4.1, Supports for Reinforcement Used in Concrete

5. International Code Council (ICC):

   a. IBC, International Building Code

   b. ICC-ES, International Code Council Evaluation Service

1.02 SUBMITTALS

A. Shop Drawings:

1. Prepare shop drawings in accordance with ACI 315 and ACI MNL-66.

2. Shop drawings shall include placing drawings, bending details, and bar lists with bar marks.

3. Show size, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices,

tie spacing, hoop spacing, supports for concrete reinforcement, and location of bars and welded wire fabric in structures.

4. Provide details for mechanical splice couplers and welding splices as permitted in the Drawings.

5. Bill reinforcing bars for walls on elevations. When more than one wall is identical, only one such wall is required to be detailed.

6. Bill reinforcing bars for slabs on plans. When more than one slab is identical, only one such slab is required to be detailed.

7. Location and arrangement of cast-in-place accessories shall be clearly indicated.

8. Include locations where support bars and chairs are required. Indicate typical minimum spacing requirements if exact locations are not shown.

B. Product Data:

1. Mechanical Splices:

a. Submit requests to use mechanical splices not indicated on the Contract Drawings.

b. Include product data sheets for all mechanical splice products.

c. Clearly indicate locations, sizes, and types of mechanical splices on Shop Drawings.

2. Reinforcement Accessories:

a. Submit product data for tie wire products.

b. Submit product data precast concrete or fiber-reinforced concrete supports.

C. Certified Mill Test Reports:

1. Submit manufacturer’s certified mill test reports on each heat of reinforcing delivered showing physical and chemical analysis before placing reinforcement.

1.03 QUALITY ASSURANCE

A. **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.

B. Minimum concrete cover for reinforcement shall comply with ACI 350, except as shown on Drawings.

C. Splices other than lap splices shall not be used except where permitted in writing by the Engineer.

D. Comply with provisions of ACI 301 except where more stringent requirements are shown or specified.

E. Proprietary products, including mechanical splices, shall have an active ICC-ES Evaluation Report.

F. Mill test reports including chemical analysis, tensile properties, and bend test shall be examined for all reinforcing. Conform to one of the following:

1. Maintain positive identification of reinforcing by heat number. Provide certified mill test reports to Testing Laboratory.

2. Where positive identification cannot be made and procedures are not deemed adequate to ensure compliance, Testing Laboratory will randomly sample and make one tensile and one bend test from each 2-1/2 tons or fraction thereof of each size of reinforcement. **Contractor** will bear the cost of testing.

1.04 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Store concrete reinforcement material at the site to prevent permanent bending, 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

2.01 BAR REINFORCEMENT

A. Shall be Grade 60, deformed billet bars conforming to ASTM A615, unless otherwise noted on the Drawings.

B. Where welding is permitted by the Engineer, low-alloy steel bar reinforcement shall conform to ASTM A706.

2.02 WELDED WIRE FABRIC (WWF)

A. Supply WWF in flat sheets conforming to ASTM A1064. WWF supplied in rolls is prohibited.

B. Wire type shall be plain (W) or deformed (D) as indicated on Drawings.

1. Plain (W) WWF shall have a minimum yield strength of 65,000 psi.

2. Deformed (D) WWF shall have a minimum yield strength of 70,000 psi.

C. Spacing and size of transverse and longitudinal wires are indicated on Drawings.

2.03 HEADER BAR REINFORCEMENT

A. Shall be Grade 60, deformed billet bars conforming to ASTM A970.

B. The net bearing area of the head shall be at least four times the net area of the bar but not less than the area required to develop the minimum tension forces indicated on the Drawings.

2.04 SPIRALS

A. Shall be Grade 60, deformed billet bars conforming to ASTM A1064.

B. Spirals shall be anchored by 1-1/2 extra turns of spiral bar or wire at each end.

2.05 MECHANICAL SPLICES

A. Shall be Type 1, Grade 60, shop fabricated bars conforming to ASTM A318.

B. Metal Sleeves: Steel sleeve with cast filler metal, capable of developing, under tension or compression, 125 percent of specified yield strength of the spliced reinforcing bar.

C. Mechanical Threaded Connections: Metal coupling sleeve with internal threads which engage threaded ends of bars to be spliced, and develops under tension or compression, 125 percent of the specified yield strength of the splice reinforcing bar.

2.06 ACCESSORIES

A. Tie Wire: Minimum 16-gage black annealed wire conforming to ASTM A1064.

B. Bar supports shall meet the following requirements:

1. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

2. At surfaces not exposed to view in completed structure: Precast concrete bar supports with two 16 ga. embedded wires or CRSI Class 2 wire supports.

3. Supports placed against ground or on top of vapor barrier: Precast concrete blocks not less than 3 inches square with two 16 ga. embedded wires.

4. At Architectural Concrete and surfaces exposed to weather: CRSI Class 2 stainless steel or CRSI Class 1 plastic protected.

5. Where support is no closer to concrete surface than 1/2 inch: CRSI Class 3 wire supports.

2.07 FABRICATION

A. Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI Manual of Standard Practice and ACI 315 minimums.

B. In case of fabricating errors, do not re-bend, retemper, heat, deform, or straighten reinforcement.

C. Field fabrication of reinforcing is not permitted.

D. Welding of reinforcement is not permitted unless permitted by the Engineer in writing.

E. Reinforcement with any of the defects listed below will not be permitted in the Work:

1. Bar lengths, bends, and other dimensions exceed 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

3.01 INSTALLATION

A. Before placing concrete, clean reinforcement of loose scale, rust, dirt, grease, and other substances which would impair bond with concrete.

B. Do no cut or puncture vapor retarders. Repair damage and reseal vapor retarders before placing concrete as required.

C. Space metal chairs, bolsters, spacers, and hangers in accordance with ACI 315 and CRSI Manual of Standard Practice. No wood blocks are allowed for rebar support.

D. Provide sufficient numbers of supports of strength required to carry reinforcement without sagging.

E. Placing of Reinforcement:

1. Placing tolerances shall be in conformance with the Drawings and the CRSI Manual of Standard Practice.

2. Place reinforcement to obtain the minimum concrete coverage as shown in the Drawings. Conform to minimum coverage requirements in ACI 350 where not indicated.

3. Arrange, space, and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations.

4. Bars shall not be spaced closer than 1-1/2 diameters of the largest of two adjacent bars, 1-1/2 times the maximum aggregate size, nor one inch, except at bar laps.

5. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.

6. 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.

7. After placing, maintain bars in a clean condition until completely embedded in concrete.

F. Lap Splices:

1. Install bar reinforcement in as long lengths as practical.

2. Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire.

3. Stagger splices of adjacent bars where possible.

4. Comply with requirements shown for minimum lap of spliced bars on Drawings or as specified in ACI 350.

5. Install welded wire fabric in as long lengths as practical.

6. Lap adjoining pieces of welded wire fabric at least one full mesh and lace splices with 16-gauge wire and tie.

G. Reinforcement Around Openings:

1. Place an equivalent area of steel around pipe penetrations or openings and extend on each side sufficiently to develop bond in each bar.

2. See the Details on the Drawings for bar quantities and extension length each side of openings.

3. Where welded wire fabric is used, provide extra reinforcing using fabric or deformed bars.

H. Mechanical Splices:

1. Install mechanical bar couplers per the manufacturer's installation recommendations. Maintain clearance and concrete coverage at couplers.

2. Threaded dowels shall be installed into clean internally threaded welded couplers.

3. Prior to installing threaded dowels, ensure that the external threads and internal threads in the coupler are clean and free of any dirt, cement paste, rust, or other contaminants that would interfere with the proper installation.

4. Dowels shall be aligned, turned, and tightened per the manufacturer's installation recommendations.

I. Welded Reinforcement:

1. Welding shall not be permitted unless approved by the Engineer and the **Contractor** submits detailed shop drawings, qualifications, and radiographic nondestructive testing procedures for review by the Engineer.

2. Reinforcing bars to be welded shall conform to ASTM A706; other bars shall not be welded.

3. 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, published by the American Welding Society and the applicable portions of ACI 350, current edition.

4. The **Contractor** shall test 10 percent of all welds using radiographic, nondestructive testing procedures referenced in this code.

3.02 FIELD INSPECTION

A. Testing Laboratory will:

1. Review Quality Assurance procedures for maintaining identification of steel. Collect certificates of compliance and test reports for reinforcing steel.

2. Special Inspect placement of reinforcement for conformance with the Contract Documents and as required by IBC Chapter 17.

3. Special Inspect installation of mechanical couplers in accordance with requirements of applicable ICC-ES evaluation report.

4. Special Inspect shop and field welding as required by IBC Chapter 17.

+++ END OF SECTION 03200 +++

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 SCOPE

A. This specification describes the design, mixing, and placement of cast-in-place concrete as indicated in the Contract Documents.

B. Included in this specification are the requirements for concrete mix designs that include synthetic fiber reinforcement.

C. Furnish labor, materials, equipment, and incidentals necessary to fabricate and install cast-in-place concrete and complete the Work.

D. Related Work Specified Elsewhere:

1. Section 03100 – Concrete Formwork

2. Section 03150 – Concrete Joints & Accessories

3. Section 03200 – Concrete Reinforcing

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):

a. 117, Specifications for Tolerances for Concrete Construction

b. 201.2R, Guide to Durable Concrete

c. 212.3R, Report on Chemical Admixtures for Concrete

d. 214R, Evaluation of Strength Test Results of Concrete

e. 222.1, Provisional Standard Test Method for Water-Soluble Chloride Available for Corrosion of Embedded Steel in Mortar and Concrete using the Soxhlet Extractor

f. 225R, Guide to the Selection and Use of Hydraulic Cements

g. 228.1R, Report on Methods for Estimating In-Place Concrete Strength

h. 301, Specifications for Concrete Construction

i. 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete

j. 305R, Guide to Hot Weather Concreting

k. 306R, Guide to Cold Weather Concreting

l. 311.5, Guide for Specifying Batch Plant Inspection and Testing of Ready-Mixed Concrete

m. 318, Building Code Requirements for Structural Concrete and Commentary

n. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary

o. 350.1, Standard Practice for Tightness Testing of Environmental Containment Structures and Commentary

p. 350.5, Specifications for Environmental Concrete Structures

q. 506.2, Specification for Shotcrete

r. 544.1R, Report on Fiber Reinforced Concrete

s. 544.3R, Guide for Specifying, Proportioning, and Production of Fiber-Reinforced Concrete

2. American Society for Testing and Materials International (ASTM):

a. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field

b. C33/C33M, Standard Specification for Concrete Aggregates

c. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

d. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

e. C94/C94M, Standard Specification for Ready-Mixed Concrete

f. C114, Standard Test Methods for Chemical Analysis of Hydraulic Cement

g. C138/C138M, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

h. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete

i. C150/C150M, Standard Specification for Portland Cement

j. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

k. C172/C172M, Standard Practice for Sampling Freshly Mixed Concrete

l. C173/C173M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

m. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

n. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

o. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete

p. C469/C469M, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

q. C494/C494M, Standard Specification for Chemical Admixtures for Concrete

r. C595/C595M, Standard Specification for Blended Hydraulic Cements

s. C597, Standard Test Method for Pulse Velocity through Concrete

t. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

u. C642, Standard Test Method for Density, Absorption, and Voids in Hardened Concrete

v. C685/C685M, Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing

w. C803/C803M, Standard Test Method for Penetration Resistance of Hardened Concrete

x. C805/C805M, Standard Test Method for Rebound Number of Hardened Concrete

y. C873/C873M, Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds

z. C989/C989M, Standard Specification for Slag Cement for Use in Concrete and Mortars

aa. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution

bb. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

cc. C1064/C1064M, Standard Test Methods for Temperature of Freshly Mixed Hydraulic-Cement Concrete

dd. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

ee. C1116/C1116M, Standard Specification for Fiber-Reinforced Concrete

ff. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete

gg. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures

hh. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)

ii. C1293, Standard Test Method for Determination Length of Change of Concrete Due to Alkali-Silica Reaction

jj. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

kk. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

ll. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

3. National Ready Mixed Concrete Association (NRMCA).

1.03 PRE-INSTALLATION MEETINGS

A. Contractor shall schedule Pre-Installation meetings prior to any concrete placement to review project requirements, acceptance criteria, responsibilities, and pour schedules. At a minimum, the following individuals shall be included in the meetings:

1. Contractor's Superintendent

2. Concrete Subcontractors

3. Testing Agency

4. Engineer

5. Owner

B. The following items shall be addressed during the Pre-Installation meetings at a minimum:

1. Special inspection and testing and inspecting agency procedures for field quality control.

2. Construction joints, control joints, isolation joints, and expansion joints.

3. Vapor-retarder installation.

4. Cold and hot weather concreting procedures.

5. Concrete finishes and finishing.

6. Curing procedures.

7. Forms and form-removal limitations.

8. Initial curing and field curing of field test cylinders (ASTM C31)

9. Methods for achieving specified floor and slab flatness and levelness.

1.04 SUBMITTALS

A. Concrete Mix Designs:

1. Submit concrete mixture proportions and characteristics for cementitious material content, w/cm ratio, slump, nominal maximum size of coarse aggregate, air content, admixtures, chloride-ion concentration, and 28-day compressive strength.

2. Submit method and field test records used to establish the required average strength.

3. Submit for acceptance and test data used to establish the average compressive strength of the mixture.

4. Submit the following data for concrete materials not older than 90 days unless otherwise specified:

    a. For cementitious materials: Types, manufacturing locations, shipping locations, and certificates showing compliance with ASTM C150, C595, C618, C845, or C989.

    b. For aggregates: Types, pit or quarry locations, producer names, gradations, specific gravities, and evidence not more than 90 days old.

        i. Test results for aggregate soundness, abrasion, and reactivity may be older than 90 days, but not older than 1 year, provided test results for the other properties specified in ASTM C33 indicate that the aggregate quality has not changed.

        ii. Submit alkali aggregate reactivity test results for aggregates.

    c. For admixtures: Types, brand names, producers, manufacturer's technical data sheets, and certification data.

    d. For water and ice: Source of supply.

B. Additional Product Data:

1. Submit fiber reinforcement type, length, and dosing ratio and identify which mix designs are intended to receive fiber reinforcement.

2. Submit vapor retarder type, thickness, and associated adhesives and tapes.

3. Submit curing materials and floor/slab treatment products.

C. Testing Agency Reports:

1. Testing agencies shall report results of concrete and concrete materials tests and inspections performed during the course of the Work to Owner, Engineer, and Contractor.

2. Strength test reports shall include the location in the Work where the batch represented by test was deposited and the batch ticket number.

3. Reports of strength tests shall include detailed information of storage and curing of specimens before testing. Final reports shall be provided within 7 days of test completion.

D. Concrete Delivery Tickets:

1. Submit each batch ticket for each concrete truck to Testing Agency and Contractor before unloading at Site.

2. Copies of batch tickets shall be made available to the Testing Agency, Contractor, Engineer, and Owner following completion of all concrete pours.

3. Tickets shall be prepared in accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.

4. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

E. Concrete Repair Materials:

1. Cementitious patching mortar product data, test reports, and manufacturer's installation instructions.

2. Epoxy crack-injection adhesive product date, test reports, and manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACE Flatwork Concrete Finisher/Technician.

B. Batch Plant: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.

C. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated. A testing agency will be selected by the Owner to perform material evaluation tests.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technicians, Grade 1, according to ACI CP-1 or an equivalent certification program.

2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

E. Materials and installed work may require testing and re-testing at any time during progress of Work. Tests, including re-testing of rejected materials for installed Work, shall be done at Contractor's expense.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Transport and deliver concrete in equipment conforming to the requirements of ASTM C94.

B. Store cementitious materials in dry, weather-tight buildings, bins, or silos that will exclude contaminants.

C. Store and handle aggregate in a manner that will avoid segregation and prevent contamination with other materials or other sizes of aggregates. Store aggregates to drain freely. Do not use aggregates that contain frozen lumps.

D. Protect mixing water and ice from contamination during storage and delivery.

E. Protect stored admixtures against contamination, evaporation, or damage. Provide agitating equipment for admixtures used in the form of suspensions or unstable solutions to ensure thorough distribution of the ingredients.

Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.

F. Time for completion of discharge shall comply with ASTM C94, unless otherwise permitted by the Engineer. When discharge is permitted after more than 90 minutes have elapsed since batching or after the drum has revolved 300 revolutions, verify that air content of air-entrained concrete, slump, and temperature of concrete are as specified.

PART 2 – PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Cementitious material content shall meet the following minimum requirements:

Nominal Maximum Size of Aggregate (in)	Minimum Cementitious Materials Content (lb/yd^3)
1-1/2	515
1	535
¾	560
½	580
3/8	600

B. Slump or Slump Flow:

1. Unless otherwise specified, Contractor shall select a target slump or slump flow at the point of delivery of concrete mixtures for each application.

2. Selected target slump shall not exceed 9 inches.

3. Selected target slump flow shall not exceed 30 inches.

4. The target slump or slump flow value shall be enforced for the duration of Project.

C. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218 at an age between 28 days and 42 days.

Class of Concrete	28-Day Compressive Strength (psi)	Maximum Aggregate Size (in)	Maximum w/cm Ratio	Air Content Range (%)
A1	5000	1"	0.40	4.5 - 7.5
A2*	5000	1”	0.40	4.5 – 7.5
B	4500	1-1/2"	0.45	4.0 - 7.0
C	4000	1"	0.50	3.0 - 6.0
D	2500	1"	N/A	N/A

*Indicates that mix shall include fiber reinforcement.

1. Class A1:

    a. Locations: Environmental concrete structures including:

        1) Chemical Pavilion Foundations

    b. Exposure Class: ACI 350 EF2, ES0, EC1, ECA2, EE1

    c. Water-Soluble, Chloride-Ion Content: 0.10 percent by weight of cement maximum.

    d. Additional Requirements: No calcium chloride admixtures are permitted.

2. Class A2:

    a. Locations: Grout for tanks with fiber reinforcement

    b. Exposure Class: ACI 350 EF2, ES0, EC1, ECA2, EE1

    c. Water-Soluble, Chloride-Ion Content: 0.10 percent by weight of cement maximum.

    d. Fiber Reinforcement: Include in mix at fiber manufacturer’s recommended dosage ratio.

    e. Additional Requirements: No calcium chloride admixtures are permitted.

3. Class B:

    a. Locations: Sidewalks and Pavements.

b. Exposure Class: ACI 318 F2, S0, W0, C1

c. Water-Soluble, Chloride-Ion Content: 0.30 percent by weight of cement maximum.

4. Class C:

a. Locations: All locations unless noted otherwise

b. Exposure Class: ACI 318 F1, S0, W1, C1

c. Water-Soluble, Chloride-Ion Content: 0.30 percent by weight of cement maximum.

5. Class D:

a. Locations: Duct banks and pipe encasements.

b. Exposure Class: ACI 318 F0, S0, W0, C1

c. Water-Soluble, Chloride-Ion Content: 0.30 percent by weight of cement maximum.

2.02 CEMENTITIOUS MATERIALS

A. Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete mix designs submitted or used in trial mixtures.

B. Portland Cement: ASTM C150, Type II.

1. Use one brand of cement throughout the Project.

2. Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.

3. Provide documentation of test results in accordance with ASTM C1012, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

C. Fly Ash: ASTM C618, Type F

a. When fly ash is used, quantity shall not be less than 15 percent or more than 25 percent by weight of total cementitious materials.

D. Ground Granulated Blast Furnace Slag Cement: ASTM C989, Grade 120.

E. Silica Fume: ASTM C1240.

F. Potential alkali-aggregate reactivity of concrete:

a. Alkali content of cement used in proposed concrete mixture shall not be greater than alkali content of cement used in test for potential alkali-aggregate reactivity.

b. Use low alkali cement and incorporate pozzolans into the concrete mixture as necessary to satisfy testing for potential alkali reactivity.

2.03 AGGREGATE MATERIALS

A. Fine and coarse aggregates for concrete mixes shall be uniformly graded. Concrete mixes shall not contain gap graded aggregates.

B. Fine aggregate shall be natural sand having clean, hard, durable, uncoated grains and free from deleterious substances and shall conform to ASTM C 33. The use of manufactured sand aggregate is prohibited.

C. Coarse aggregate shall be crushed stone having clean, hard, durable, uncoated particles conforming to ASTM C 33. The maximum size of coarse aggregates shall be as follows:

1. 1-1/2 inch for rigid concrete pavements and sidewalks.

2. 1 inch for all other concrete.

D. Potential alkali-aggregate reactivity of concrete:

1. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).

2. Aggregates shall have been tested to determine potential alkali-aggregate reactivity in concrete in accordance with ASTM C1260 or ASTM C1567.

a. Aggregates that indicate expansion greater than 0.10 percent at 16 days after casting shall not be used unless they have been shown to be non-deleteriously reactive in accordance with ASTM C1293, with less than 0.04 percent expansion at 1 year for cement-aggregate combinations or less than 0.04 percent expansion at 2 years for combinations with pozzolan or slag.

2.04 WATER

A. Mixing water for concrete and water used to make ice shall be potable water complying with ASTM C94.

2.05 ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers. Use in compliance with manufacturer's printed instructions.

B. Do not use admixtures which have not been incorporated and tested in the approved mixes.

C. Air-Entraining Admixture: ASTM C260

D. Water-Reducing Admixture: ASTM C494, Type A or Type D.

E. High-Range, Water-Reducing Admixture: ASTM C494, Type F or Type G.

F. Retarding Admixture: ASTM C494, Type B.

G. Accelerating Admixture: ASTM C494, Type C.

H. Calcium Chloride: Not Permitted.

2.06 CHLORIDE ION CONTENT

A. The maximum water-soluble chloride-ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the specified percent by weight limit for each mix class of concrete.

B. When testing is performed to determine water-soluble chloride-ion content, test procedures shall conform to ASTM C1218.

2.07 FIBER REINFORCEMENT

1. Micro-Synthetic Fiber Reinforcement:

    1. Type III fibers conforming to ASTM C1116, Part 4.1.3.

    2. 100 percent virgin polypropylene self-fibrillating fibers conforming to ASTM D7508/D7508M.

    3. Reprocessed olefin materials are not allowed.

    4. Multi-design gradation.

    5. Specific Gravity: 0.91 minimum.

6. Equivalent Flexural Residual Strength: 150 psi, equivalent to 0.18% steel reinforcement ratio.

7. Fiber Length: 0.50 inch to 1.5 inch.

B. Use fibrillated bundles to allow uniform distributed angular fibrils (fiber strands) when mixed into concrete.

2.08 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils thick.

B. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.09 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq.yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 degrees Fahrenheit: Black.

b. Ambient Temperature between 50 degrees Fahrenheit and 85 degrees Fahrenheit: Any color.

c. Ambient Temperature Above 85 degrees Fahrenheit: White.

D. Curing Paper: 8-feet-wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

E. Water: Potable or complying with ASTM C1602.

2.10 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C881, bonding system Type IV, free of VOCs.

B. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.

C. Color: Provide epoxy crack-injection adhesive and capping adhesive as indicated by manufacturer's designations.

2.11 REPAIR MATERIALS

A. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent surface elevations.

1. Cement Binder: ASTM C150 portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.

2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109.

PART 3 - EXECUTION

3.01 CONCRETE MIXING

A. 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 by the Engineer.

B. 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. Plant equipment and facilities: Conform to National Ready Mix Concrete Association "Plant and Delivery Equipment Specification".

4. Mix concrete in revolving type truck mixers, which are in good condition, and which produce thoroughly mixed concrete of the specified consistency and strength.

5. Do not exceed the proper capacity of the mixer.

6. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.

7. Do not allow the drum to sit while in transit.

8. Mix at proper speed until concrete is discharged.

9. 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.

10. 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.

C. For concrete mixes that include fiber reinforcement:

1. Add fibers into the mixing system at any time, except when the cement is being introduced, in accordance with the fiber manufacturer's instructions.

2. Fiber-reinforced concrete shall be mixed in accordance with the fiber manufacturer's instructions for even dispersion of fiber throughout the concrete.

3.02 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not add any water at the jobsite unless water is withheld at the batch plant and the amount of water withheld is recorded on the batch ticket. Trucks that do not have amount of water withheld shall not be permitted to add water at the jobsite.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

3.03 CONCRETE PLACEMENT

A. Inspection of Work Before Placing Concrete:

1. Inspect the area to receive concrete for any deficiencies, which would prevent proper placing of concrete. Do not proceed with placing concrete until such deficiencies are corrected.

2. Do not place in the concrete any item that is not required to be in the concrete by the Drawings and Specifications. Insert all the items shown on the Drawings or specified properly positioned and secured. Openings other than those which are facilitated by sleeves shall be properly formed and positioned only after approval of the Engineer.

3. Remove hardened, or partially hardened, concrete on forms or reinforcement before placing concrete.

4. Do not place concrete on earth until the fill or excavation has been prepared as set forth under applicable sections of the Specifications for that work.

B. Place concrete continuously so that no concrete will be placed on concrete, which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure, which will cause segregation.

1. Screed concrete, which is to receive other construction to the proper level to avoid excessive skimming or grouting.

2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.

3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and position and secure.

4. Unless otherwise approved, place concrete only when Engineer is present.

C. Concrete Conveying:

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods, which will prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.

3. Do not use chutes for distributing concrete unless approved in writing by the Engineer.

4. Pumping of concrete is permitted, however, do not use aluminum piping to convey the concrete.

5. When concrete is pumped and pumping equipment must be primed, flush all excess primer from pump line and dispose of contaminated concrete before pumping and placing concrete into forms.

D. Placing Concrete into Forms:

1. Deposit concrete in forms in horizontal layers not deeper than 18 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete, which is being integrated with fresh concrete is still plastic with adequate vibration.

2. Do not permit concrete to free fall within the form from a distance exceeding 4 feet. Use "elephant trunks" and tremies to prevent free fall and excessive splashing on forms and reinforcement.

3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by the Engineer.

5. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6 inches into the preceding layer. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.

6. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.

7. For fiber-reinforced concrete, remove and discard visible fiber balls during concrete discharge and placement.

E. Placing Concrete Slabs and Sidewalks:

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of expansion joints, until the placing of a panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

3. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations. Coordinate applying contraction joint, with finishing operations.

F. Cold Weather Placing:

1. Protect all concrete Work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306.1 and as herein specified.

2. When the air temperature has fallen to or may be expected to fall below 40 F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50° F and 70° F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to ensure that the ambient temperature does not fall below 30° F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating and avoid thermal shock due to sudden cooling or heating.

3. When air temperature has fallen to or is expected to fall below 40° F uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55° F and not more than 90° F at point of placement.

4. Do not use frozen materials containing ice or snow. Ascertain that forms, reinforcing- steel, and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.

5. Do not use salt and other materials containing anti-freeze agents or chemical accelerators, or set-control admixtures, unless approved by the Engineer, in mix designs.

G. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305.1 and as herein specified.

2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90° F when the temperature is rising and below 85° F when the temperature is falling. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated by the Engineer in the total amount of mixing water.

3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

4. Wet forms thoroughly before placing concrete.

5. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.

6. Do not use set-control admixtures unless approved by the Engineer in mix designs.

7. Obtain Engineer's approval of other methods and materials proposed for use.

H. Minimum Time between Adjacent Placements:

1. Construction or Control Joints: 7 days.

2. Construction joint between top of footing or slab, and column or wall: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.

3. Expansion or Contraction Joints: 1 day.

4. For columns and walls with a height in excess of 10 feet, wait at least 2 hours before depositing concrete in beams, girders, or slabs supported thereon.

5. For columns and walls 10 feet in height or less, wait at least 1 hour prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.

3.04 CONCRETE FINISHING

A. Rubbed Stone Finish:

1. Stone rubbed finish shall be applied on a Smooth Form Finish, and by rubbing the surfaces with carborundum stone and water. The rubbing shall produce an even and smooth finish of uniform color and texture without the addition of any cement to the process, using only the cement paste produced by the rubbing of the concrete.

2. Areas to receive this finish shall be rubbed after the moist curing has been completed.

3. The following surfaces shall receive a stone rubbed finish surface coating:

   a. All exterior wall concrete surfaces to levels not less than 6-inches below finish grade.

   b. All interior wall concrete surfaces within buildings and other such surfaces exposed to view in the finished work (except floor slabs).

   c. The interior side of liquid containment structure walls to a level not less than 12-inches below normal liquid level, including top of walls.

B. Smooth Form Finish is required for all concrete surfaces exposed to view in the completed work whether exposed to view or not in the completed work. Accomplish the required patching and the following touch-up:

1. Remove all burrs.

2. Remove all form marks.

3. Smooth out lines of indentations.

C. Rough Form Finish shall be produced by filling all tie holes and honeycomb and in other respects leaving the surface as formed. All concrete surfaces which will be covered by earth and which will not be visible in the completed structure (except as noted above for liquid containment structure walls which shall have a Smooth Form Finish), may receive a Rough Form Finish.

3.05 FINISHING FLOORS AND SLABS

A. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.

2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.

3. Apply scratch finish to surfaces to receive concrete floor toppings.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.

2. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.

3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.

2. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance.

3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

4. Do not add water to concrete surface.

5. Do not apply hard-troweled finish to concrete, which has total air content greater than 3 percent.

6. Apply a trowel finish to surfaces exposed to view.

7. Finish surfaces to the following tolerances, in accordance with ASTM E1155 (ASTM E1155M), for a randomly trafficked floor surface:

    a. Slabs on Ground (Operations Building)

        1) Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.

D. Broom Finish

1. Broom finish shall be applied to concrete surfaces for slip resistance in the following areas:

    a. All exterior sidewalks, walkways and platforms.
    b. All steps, stairs and landings, both interior and exterior.

2. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.06 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 301 and ACI 306.1 for cold-weather protection during curing.

C. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.

D. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.

E. Cure concrete by leaving enclosed in forms for at least 7 days, by applying a moisture-retaining cover, by applying a liquid curing compound, or by combining these methods, as specified.

F. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for the full 7 day curing period or until forms are removed.

2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.

3. If forms are removed prior to 7 days of curing, continue curing by covering concrete with a moisture-retaining cover or with a liquid curing compound as follows:

    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.

    b. Continuous Sprinkling: Maintain concrete surface continuously wet.

    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.

    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.

    e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

        1) Recoat areas subject to heavy rainfall within three hours after initial application.

        2) Maintain continuity of coating and repair damage during curing period.

3.07 EPOXY CRACK INJECTION

A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.

B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.

D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch thick by 1 inch wider than crack.

E. Inject cracks wider than 0.003 inch to a minimum depth of 8 inches.

F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.

G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

3.08 CONCRETE SURFACE REPAIRS

A. As determined by the Engineer, any concrete which is out of alignment or level, has a defective surface, or has defects which reduce its structural adequacy, shall be considered as not conforming with the Drawings and Specifications and shall be rejected.

B. Do not take any remedial action on concrete with any defect without the permission of the Engineer.

C. Unless the Engineer grants permission to patch the rejected concrete, remove the rejected concrete and replace it with concrete that conforms to the Drawings and Specifications. The location of cut lines and the extent of removal will be determined by the Engineer.

D. If the Engineer grants permission to patch the rejected concrete, it shall be done in accordance with the following:

1. Permission to patch rejected concrete will not be a waiver of the Engineer's right to require complete removal of the rejected concrete if the patching does not, in the Engineer's judgement, restore the concrete to the requirements of the Specifications and Drawings.

2. Patching shall be accomplished after the curing is completed.

3. Repairing Formed Surfaces:

    a. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

b. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

1) Limit cut depth to 3/4 inch.

2) Make edges of cuts perpendicular to concrete surface.

3) Clean, dampen with water, and brush-coat holes and voids with bonding agent.

4) Fill and compact with patching mortar before bonding agent has dried.

5) Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

c. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

1) Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.

2) Compact mortar in place and strike off slightly higher than surrounding surface.

3) Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

4. Repairing Unformed Surfaces:

a. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

1) Correct low and high areas.

2) Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

b. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

c. After concrete has cured at least 14 days, correct high areas by grinding.

d. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

e. Finish repaired areas to blend into adjacent concrete.

3.09 QUALITY CONTROL TESTING

A. The Independent testing laboratory shall have access to all places where concrete materials and concretes are manufactured, stored, proportioned, mixed, placed and tested. Duties shall include, but not necessarily be limited to the following:

1. Make, store, transport, cure and test compression specimens made during the placing of concrete.

2. Compression test specimens shall be tested in accordance with ASTM C39.

3. Test reports shall show all pertinent data, such as:

a. Class of concrete and location of pour.

b. Date and time of pour and when sample was obtained.

c. Truck and batch ticket numbers for sampled concrete.

d. Date and age of specimen which was broken.

e. Compressive strength of specimen.

f. Field test results for concrete slump, air content, concrete temperature, and ambient air temperature at time of pour.

4. Electronic copies of all tests shall be sent to the Contractor, Engineer, and Owner.

B. Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 50 cubic yards of concrete, nor less than once for each 5,000 square feet of surface area for slabs or walls.

C. Each set of samples shall be comprised of a minimum of six (6) 4 x 8 in cylinders made from the same sample of concrete, taken in accordance with ASTM C172 at the point of delivery, handled and standard cured in accordance with ASTM C31, and tested in accordance with ASTM C39 at the following intervals, unless otherwise permitted by the Engineer:

1. One (1) cylinder tested at 7 days or less.

2. One (1) cylinder tested at 14 days or less.

3. Three (3) cylinders tested at 28 days.

4. One (1) cylinder held in reserve.

D. Test for unit weight of concrete when the first load of each class of concrete is delivered and thereafter at the discretion of the testing laboratory or as directed by the Engineer.

E. Test for air content when the first load of each class of concrete is delivered and do not place concrete until air content has been verified. Test for air content thereafter at the discretion of the testing laboratory or as directed by the Engineer.

F. Test for concrete temperature when the first load of each class of concrete is delivered and thereafter at the discretion of the testing laboratory or as directed by the Engineer.

3.10 EVALUATION OF COMPRESSION TESTS

A. Evaluation of compression test results shall be as follows:

1. For each class of concrete, compression-strength tests for laboratory-cured cylinders shall be considered satisfactory if the averages of the results of all sets of three consecutive compression-strength tests equal or exceed the 28-day design compression-strength specified; and, no individual cylinder strength test falls below the required compression strength by more than 500 psi.

2. Strength tests of specimens cured under field conditions may be required by the Engineer to check the adequacy of curing and protecting of the concrete placed.

3. Specimens shall be molded by the field-testing laboratory at the same time and from the same samples as the laboratory-cured specimens.

B. 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.

C. 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.

D. 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.

+++ END OF SECTION 03300 +++

SECTION 03410
PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SCOPE

A. This section covers the design, materials, fabrication, erection and related operations required to furnish and install precast concrete structures and accessory items. Precast concrete structures shall serve as vaults for isolation valves, pressure reducing valves, air release and vacuum valves and other pipeline appurtenances as shown on the Drawings.

B. Precast concrete structures shall be provided with factory applied waterproofing if indicated on the Drawings.

C. Precast vaults for large meters are specified in Section 03460.

1.02 QUALITY ASSURANCE

A. 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 Drawings or specified herein.

1. ACI 318 - Building Code Requirements for Reinforced Concrete

2. ASTM C31 - Making and Curing Concrete Test Specimens in the Field

3. ASTM C33 - Standard Specification for Concrete Aggregates

4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

5. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete

6. ASTM C150 - Standard Specification for Portland Cement

7. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete

8. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

9. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete

10. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

11. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures

12. ASTM C890 – Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Pre-cast Concrete Water and Wastewater Structures

13. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures

14. AWS D1.4 - Structural Welding Code - Reinforcing Steel

B. Acceptable Manufacturers and Erectors: Manufacturers and erectors shall have a minimum of 2 years experience in precast structural concrete work of the quality and scope required on this project. The manufacturer shall be PCI Certified and have an established quality assurance program in operation.

C. Sampling and Testing:

1. General: Samples and tests required below and other tests are to be made by and at the Contractor's expense. The tests shall be performed by an independent commercial testing laboratory or by the manufacturer's lab subject to approval by the Engineer. Certified copies of test reports shall be furnished as required in this Section and shall include all test data and results.

2. Concrete Testing: During the progress of the work, plastic concrete, as delivered to the casting site, shall be sampled and tested for slump, air content and compressive strength in accordance with ACI 381, Part 2, Chapter 3, and Part 3, Chapter 4. No fewer than 6 cylinders shall be made during each concreting cycle. Not more than 1 test in 10 shall fall below the specified strength.

3. Slump Tests: Slump tests shall be in accordance with ASTM C143.

4. Failure to Meet Strength Requirements: If compressive strength tests fail to meet the above requirements, the Engineer may require load tests to be made in accordance with ACI 318. Units failing to meet requirements of the load tests shall not be used. Load tests shall be performed at the expense of the Contractor.

1.03 SUBMITTALS

A. 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. Shop Drawings: Furnish complete details of design, manufacture, fabrication, installation and erection. Location of all inserts and openings shall be shown.

2. Design Calculations: Submit manufacturer's design calculations used in design of the precast concrete structure and certification, signed and sealed by a Professional Engineer registered in the State of Georgia that the structure design and construction comply with the specified design conditions and the referenced ASTM specifications.

3. Certified Test Reports: Before delivery of materials and equipment, four certified copies of the reports of all tests required in referenced ASTM specifications or specified herein shall be submitted to the Engineer for approval. Testing shall have been performed in an independent laboratory suitable for performance of the tests and acceptable to the Engineer. Test reports shall be accompanied by notarized certificates from the manufacturer certifying that the tested material and equipment is of the same type, quality, manufacture and make as that proposed to be supplied.

4. Submit evidence of manufacturer's plant PCI Certification.

B. (Not Used)

1.04 DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage

1. Precast structures and sections shall be inspected upon delivery to the jobsite and stored in a manner that will prevent staining and damage.

2. Substantially damaged, cracked or broken structures and sections which are deemed unsuitable for the intended use shall be rejected and removed from the jobsite.

3. The Engineer's decision will be final in determining unsuitable structure sections.

B. (Not Used)

PART 2 PRODUCTS

2.01 PRECAST CONCRETE SECTIONS

A. Design

1. Precast concrete structures shall comply with ASTM C858 except as modified herein.

2. The precast structures shall have the inside dimensions and minimum thickness of concrete as indicated on the Drawings. Minimum structure wall and slab thickness shall be 6-inches if not indicated otherwise.

3. The structural analysis and design of the structures as well as lifting devices for all precast concrete structures shall be performed by the manufacturer of the precast materials and subject to approval of the Engineer.

4. Design loads

   a. Design live and dead loads shall be in accordance with ASTM C857 and shall consist of dead load, live load, and impact load, water table hydrostatic load, and any other special loads that may be imposed upon the structure. Final design shall be based upon the governing live load that produces the maximum shear and bending moment in the given structure.
   b. The design and analysis of the structure shall be verified to insure that the anticipated field conditions and requirements for design loads are not greater than those specified in ASTM C857.

5. Provide openings in precast structures for piping and access. No field coring of openings will be allowed.

6. Before shipment, all precast concrete structures shall be inspected to determine that materials and workmanship conform to the requirements of these specifications.

B. (Not Used)

2.02 MATERIALS

A. Portland Cement

1. Portland cement shall be ASTM C150, Type I. All cement used shall be obtained from a single mill. Type III cement may be used when approved at no increase in cost to the Owner. Use regular cement as necessary to meet color requirements.

2. When precast structures are required to match finish of cast-in-place concrete, the cement shall be of the same type, brand name, and source as that used in the cast-in-place work.

B. Aggregates

1. Concrete Aggregates shall conform to ASTM C33.

2. Lightweight Concrete Aggregates shall conform to ASTM C330.

3. Fine Aggregate shall be regular sand.

C. Concrete Aggregates: Concrete aggregates shall be clean, hard, strong, and durable inert material free from injurious deleterious material.

D. Water used in mixing concrete shall be clean and free from deleterious amounts of acids, alkalis or organic materials.

E. Admixtures, including air entraining (if used); ASTM C260 (air entraining); ASTM C 494 (chemical). All admixtures shall have prior approval of the Engineer, shall be from one source, and shall be certified by the manufacturer to be free of chlorides. All admixtures shall be added at the mixer.

F. Reinforcing

1. Precast structure members shall be reinforced as required for structural stresses, temperature changes and handling.

2. Steel Reinforcement shall conform to ASTM A615, ASTM A616, or ASTM A617, Grade 40 or Grade 60.

3. Welded Wire Fabric Reinforcement shall conform to ASTM A185.

G. Forms: Forms shall be steel. Concrete forms or wood forms of a quality to produce a smooth finished product may also be used, when approved by the Engineer.

H. Form oil, or parting compound, shall not impair future coating of the concrete surfaces.

I. Miscellaneous Connections: All anchors, dowels, bolts, steel welding inserts and connecting plates indicated and/or necessary in connection with the fabrication and erection of precast concrete sections shall be provided. They shall be positioned and shall be held in position rigidly to prevent displacement while

concrete is being placed. On-site and off-site welding shall be in accordance with AWS D1.1 and AWS D12.1, as applicable.

2.03 MIXES

A. Mixing Procedures: Mixing procedure shall be the same as for cast-in-place concrete.

B. Concrete Properties

1. Water-cement ratio: maximum 40 pounds of water to 100 pounds of cement.

2. Air-entrainment: 5%.

3. Strength: minimum of 5000 psi compressive strength at 28 days.

4. Do not use calcium chloride or other salts.

2.04 SEALANTS AND MORTAR

A. Sealants and mortar shall be as specified in Section 03300.

B. (Not Used)

2.05 WATERPROOFING

A. Waterproofing shall be as recommended by the structure manufacturer and shall be a black bituminous compound of brush or spray consistency for application on below grade concrete surfaces.

B. (Not Used)

2.06 SPECIFIED CAST-IN INSERTS

A. Inserts or cast-in attachments as required by other trades shall be purchased and furnished to manufacturer by trades involved and supplied to meet production. The Contractor shall coordinate with trades and manufacturer to assure inserts are provided prior to the manufacture of the precast structure.

B. (Not Used)

2.07 CRACKS IN PRECAST CONCRETE

A. Precast concrete structures containing hairline cracks that are visible but not measurable by ordinary means may be accepted provided moist atmospheric

conditions are not present. Cracks of width measurable by ordinary means (0.01-inch wide and over) shall be cause for rejection.

B. (Not Used)

PART 3 EXECUTION

3.01 PRE-INSTALLATION INSPECTION

A. Prior to installation of precast structures, the Engineer shall inspect the structures for compliance with the contract documents. Structures shall be free of all form marks and shall have all accessories necessary for handling and erection.

B. All structures or sections that are cracked, chipped, stained or which in any way fail to comply with the contract requirements shall be subject to rejection.

C. Defective structures or sections which in the Engineer's judgment are "job site repairable" may be repaired at the project site by the Contractor at no cost to the Owner. Repairs shall be subject to the Engineer's approval and rejection of the repaired units by the Engineer shall not justify additional cost to the Contractor or an extension in the Contract time.

3.02 INSTALLATION

A. Prior to setting the precast concrete structure or sections, provide a base of six (6) inches of crushed stone material, compacted and level for a uniform bearing surface for precast concrete structure bottom. Extend crushed stone 12-inches beyond the edge of the structure base slab.

B. (Not Used)

3.03 ERECTION

A. General

1. Erection of precast structure sections shall be in accordance with the approved shop drawings. Prior to fabrication, the method proposed for the lifting, transporting, and placing of such members shall be approved by the Engineer.

2. Precast structure or sections shall not be shipped from the plant site or erected until test cylinders show that the concrete has attained the required strength.

B. Bearing Surfaces. Bearing surfaces shall be level and free from irregularities. Irregularities in bearing surfaces shall be leveled with a stiff cement mortar.

C. Mortar shall be allowed to harden before installing the structure or sections. Sections shall be installed at right angles to bearings, drawn up tight without forcing or distortion and with side plumb.

D. Grouting

1. Keyways between structure sections and other spaces shall be cleaned and filled solidly with grout. Grout that may have seeped through to surfaces in spaces below shall be removed before hardening.

2. Grout shall consist of a mixture of cementitious materials and aggregate as specified hereinafter; water shall be added in sufficient quantity to produce a fluid mixture. Fine grout shall be provided in grout spaces less than 2-inches in any horizontal dimension or in which clearance between reinforcing and masonry is less than ¾-inch. Coarse grout shall be provided in grout spaces 2-inches or greater in any horizontal dimensions or in which clearance between members is not less than ¾-inch.

3. Seals, gaskets, sealant and sealant backup shall be placed in vertical and horizontal joints between structure sections in accordance with drawing details and as specified.

3.04 PLUGGING LIFT HOLES

A. Plug lift holes used for handling, with mortar. Hammer mortar into holes until dense and excess of paste appears, then smooth flush with adjoining surface.

B. (Not Used)

3.05 CLEANING

A. After the completion of installation, all precast structures shall be cleaned by methods which will not damage the structure, sealants or adjacent materials.

B. (Not Used)

3.06 WATERPROOFING

A. Waterproofing shall be applied to all exterior surfaces of the structure. Apply in accordance with the manufacturer’s instructions. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces.

B. Protect coating from damage during backfilling.

+ + + END OF SECTION 03410 + + +

SECTION 05095
POST-INSTALLED ANCHORS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):

   a. 318, Building Code Requirements for Structural Concrete.

   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.

   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.

2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.

3. American National Standards Institute (ANSI).

4. ASTM International (ASTM):

   a. A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

   b. A143, Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

   c. A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

   d. A193/A193M, Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service.

   e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.

   f. A380, Practice for Cleaning, Descaling, and Passivation of Stainless-Steel Parts, Equipment, and Systems.

   g. A385, Practice for Providing High-Quality Zinc Coatings (Hot Dip).

   h. A563, Specification for Carbon and Alloy Steel Nuts.

i. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

j. A967, Specification for Chemical Passivation Treatments for Stainless Steel Parts.

k. E488, Standard Test Methods for Strength of Anchors in Concrete Elements.

l. F436, Specification for Hardened Steel Washers.

m. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.

n. F568M, Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

o. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

p. F594, Specification for Stainless Steel Nuts.

q. F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.

5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO UES): Evaluation Reports for Concrete and Masonry Anchors.

6. International Code Council Evaluation Service (ICC-ES):

   a. Evaluation Reports for Concrete and Masonry Anchors.

   b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.

   c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.

   d. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.

   e. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.

f. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.

7. Specialty Steel Industry of North America (SSINA):

a. Specifications for Stainless Steel.

b. Design Guidelines for the Selection and Use of Stainless Steel.

c. Stainless Steel Fabrication.

d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior below grade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete Anchors:
   a. Manufacturer's product description and installation instructions.

   b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.

   c. Adhesive Anchor Installer Certification.

2. Passivation method for stainless steel members.

3. Hot-Dip Galvanizing: Certificate of Compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.

2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY AND STORAGE

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

1. Stainless Steel Threaded Rods: F593, AISI Type 316, Condition CW.

2. Stainless Steel Nuts: F594, AISI Type 316, Condition CW.

3. Carbon Steel Threaded Rods: F1554, Grade 36.

4. Carbon Steel Nuts: F436.

5. Carbon Steel Flat and Beveled Washers (Hardened): A194/A194M, Grade 2H.

6. Galvanized Steel Threaded Rods, Nuts and Washers: ASTM A153/A153M.

B. Use stainless steel unless otherwise indicated.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as indicated on Drawings.

2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.

3. Mechanical Anchors: Comply with the requirements of ICC ES AC193 or ACI 355.2.

4. Adhesive Anchors: Comply with the requirements of ICC ES AC308 or ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:

a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).

b. DeWalt Anchors & Fasteners, Brewster, NY; Power-Stud +SD1 , +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).

c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Self-Tapping Concrete Screw Anchors:

1. Manufacturers and Products:

a. DeWalt Anchors & Fasteners, Brewster, NY; Wedge-Bolt+ (ESR 2526).

b. DeWalt Anchors & Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR 2989).

c. DeWalt Anchors & Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR 2272).

d. Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).

e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR 2713 and IAPMO UES-493).

D. Adhesive Anchors:

1. Threaded Rod:

a. Diameter as shown on Drawings.

b. Length as required to provide minimum depth of embedment indicated and thread projection required.

c. Clean and free of grease, oil, or other deleterious material.

2. Adhesive:

a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.

b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.

3. Packaging and Storage:

a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.

b. Store adhesive on pallets or shelving in a covered storage area.

c. Package Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

d. Dispose of When:

1) Shelf life has expired.

2) Stored other than in accordance with manufacturer's instructions.

4. Manufacturers and Products:

   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR 3814), or HIT HY 200 (ESR 3187).

   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).

   c. DeWalt Anchors & Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR 3298).

5. Adhesive Threaded Inserts:

   a. Type 316 stainless steel, internally threaded inserts.

   b. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS RN Insert with HIT-RE 500 V3 or HIT HY 200 adhesive.

PART 3 - EXECUTION

3.01 CONCRETE ANCHORS

A. Begin installation only after concrete or masonry to receive anchors has attained design strength.

B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer's instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on Drawings.

E. Use only drill type and bit type and diameter recommended by anchor manufacturer.

F. Clean hole of debris and dust per manufacturer's requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than

indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by Engineer and adhesive manufacturer:

a. Do not install adhesive anchors when the temperature of concrete or masonry is below 40 degrees F or above 100 degrees F.

b. Do not install prior to concrete attaining an age of 21 days.

c. Remove any standing water from hole with oil-free compressed air. Inside the surface of hole shall be dry.

d. Do not disturb the anchor during recommended curing time. Do not exceed maximum torque as specified in manufacturer's instructions.

I. Anti-seizing Lubricant: Use on all stainless-steel threads.

J. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Selected Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections in Section 01450, Special Inspection and Testing and Observation.

B. **Contractor** responsibilities and related information are included in **Section 01450 - Special Inspection, Observation, and Testing**.

3.03 MANUFACTURER'S SERVICES

A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Engineer of time and place for sessions.

+++ END OF SECTION 05095 +++

SECTION 05500
MISCELLANEOUS METALS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included: Provide all miscellaneous metal work as indicated, specified or as needed to provide a complete and proper installation.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

1.02 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. All materials in this Section are to be manufactured in the United States.

1.03 SUBMITTALS

A. Product data: Within 30 calendar days after the **Contractor** has received **Owner's** Notice to Proceed, submit:

1. Materials list of items proposed to be provided under this Section.

2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.

B. Shop drawings shall show size of components, materials of construction, connection to other components and anchorage.

C. Samples shall be submitted at the **Owner's** request.

1.04 PRODUCT HANDLING

A. Comply with pertinent provisions of **Section 01640 - Manufacturers' Services**.

PART 2 - PRODUCTS

2.01 GENERAL

A. Finished and machined faces shall be true to line and level.

B. Welding shall conform to applicable requirements of:

1. Steel products: American Welding Society Standard D1.0-63.

2. Aluminum alloy products: Recommended practices as published in "Welding Aluminum" by the American Welding Society.

C. Unless otherwise specified, materials shall conform to the following:

Structural Steel	ASTM A 36
Welded and Seamless Steel Pipe	ASTM A 53
Gray Iron Castings	ASTM A 48, Class 30
Galvanizing, General	ASTM A 123
Galvanizing, Hardware	ASTM A 153
Galvanizing, Assemblies	ASTM A 386
Aluminum (Extruded Shapes)	6063 T5 (Alum alloy)
Aluminum (Extruded Pipe)	6063 T6 (Alum alloy)
Aluminum Bars and Shapes (Structural)	6061 T6 (Alum alloy)
Bolts and Nuts	ASTM A 307
Stainless Steel Bolts, Fasteners	AISI Type 304
Stainless Steel Plate and Sheet, Wire	AISI Type 316
Welding Rods for Steel	AWS Spec for Arc Welding

D. Workmanship and finish shall be equal to the best practices of modern shops for the respective work.

1. Exposed surfaces shall have smooth finish and sharp, well defined lines and arises.

2. Sections shall be well formed to shape and size with sharp lines and angles.

3. Curved work shall be sprung evenly to curves.

4. Metal work shall be countersunk properly to receive hardware and provided with the proper bevels and clearance.

5. Cutting shall be done by shearing, sawing or flame cutting; if flame cut, the metal shall be ground back to smooth sound material.

6. Holes for bolts and screws shall be drilled.

7. Conceal fastenings where practicable.

2.02 ALUMINUM LADDERS

A. Ladders are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.

B. Space siderails 16 inches apart unless otherwise indicated.

C. Siderails: continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.

D. Rungs: extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.

E. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.

F. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted aluminum brackets.

2.03 METAL BOLLARDS

A. Fabricate metal bollards from schedule 40 steel pipe.

B. Comply with requirements in **Section 03300 - Cast-In-Place Concrete** for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.04 STEEL AND IRON SHAPES

A. Provide standard, well finished, structural shapes or commercial grade bar stock.

1. Structural steel shall conform to ASTM A 36.

2. Rolled shapes shall conform to dimensions and weights of Regular Series Shapes of AISC.

B. Pipe shall be Schedule 40, unless otherwise indicated.

2.05 ALUMINUM SHAPES

A. Provide extruded shapes of 6063-T5 alloy unless another alloy is better suited for the intended purpose.

B. Furnish structural shapes conforming to dimensions and weights of the Standard Structural Shapes of the Aluminum Association of 6061-T6.

2.06 ANCHOR BOLTS AND MISCELLANEOUS FASTENINGS

A. General:

1. Provide as indicated, or as necessary for securing work in place, and anchoring equipment in place.

2. Sizes and spacing of anchor bolts not indicated shall be as required for the intended purpose.

B. Provide anchor bolts, expansion anchors, epoxy adhesive anchors, nuts, washers and other fasteners of the materials indicated below unless otherwise indicated on the drawings.

1. Fastening structural steel shapes and plates to each other - ASTM A 325 bolts.

2. Anchoring structural steel to concrete - ASTM A 307 anchor bolts, galvanized.

3. Fastening or anchoring stainless steel or aluminum to any material - Type 316 stainless steel.

4. Anchoring process or mechanical equipment regardless of material to concrete - Type 316 stainless steel.

5. Anchoring or fastening any materials that will be submerged in water or wastewater - Type 316 stainless steel.

6. Any anchors or fasteners in contact with potable water - Type 316 stainless steel.

7. Fastening or anchoring wood or timber in non-submerged application - hot dipped galvanized.

8. Other fasteners and anchor bolts not otherwise specified - Type 316 stainless steel.

9. In contact with chlorine solution - Type 2205 duplex stainless steel.

C. Post-Installed Mechanical Anchors: See **Section 01600 - General Material and Equipment Requirements**.

D. Post-Installed Adhesive Anchors: See **Section 01600 - General Material and Equipment Requirements**.

2.07 INSERTS AND SLEEVES

A. Provide as required and needed for support of piping, equipment and apparatus, or where passages through walls, floors, etc. are required.

B. Size and material shall be as indicated, or as approved by the **Owner**.

2.08 UNISTRUT CHANNELS

A. Channels shall be accurately and carefully extruded to size from aluminum, except as noted otherwise.

B. Channels embedded in concrete shall be Type 304 stainless steel.

C. Provide a continuous slot with in-turned clamping ridges on one side of channel.

D. Fittings to be stainless steel or aluminum.

E. Unless otherwise indicated on the drawings, channels to be 1-5/8" x 1-5/8" x .105" thick.

F. Make all cuts square and free from burrs.

G. Provide end caps on channels.

H. Nuts, pipe hangers, clamps, etc. shall be units specifically intended and manufactured for use with "Unistrut" channels.

I. All nuts, bolts and clamps shall be stainless steel.

J. Provide flexible elastomer material, "Uni-cushion" or equal, between all pipe clamps or hangers and PVC, copper or stainless-steel pipe.

2.09 GALVANIZING

A. Galvanizing of structural steel, where indicated on the drawings, shall be done in accordance with standard specification for zinc coating (hot-dip) ASTM designation A 123, A 153, A 143, A 384, A 386 and A 386 latest revision.

1. Provide a minimum of 3 ounces of zinc per sq. ft. for members 1/4" thick and larger.

2. Provide a minimum of 2 ounces of zinc per sq. ft. for members less than 1/4" thick.

3. Fasteners - Comply with ASTM A 325 and ASTM A 153.

4. Pickling is required prior to galvanizing.

2.10 SHOP PAINTING

A. Clean and prime all ferrous metal surfaces with primer compatible with finish coats specified in **Section 09900 - Painting**.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all items, plumb, square and level as intended.

B. Provide coating or barrier to aluminum in contact with concrete surfaces and between dissimilar metals.

3.02 ANCHOR BOLTS

A. Set cast-in anchors to depth required by design.

B. Drill holes to depth recommended by manufacturer.

C. Apply "Never-Seize" to bolts.

D. Tighten nuts to manufacturer's recommendations using a torque wrench.

E. Maximum protrusion of bolt from top of nut - 3/8".

3.03 UNISTRUT CHANNELS

A. Mount on wall or floor using stainless steel expansion or masonry anchors or embed in concrete where indicated.

B. Install channels level and plumb.

C. Install end caps.

D. Attach securely to support structure with stainless steel wedge anchors.

3.04 REPAIR OF HOT-DIPPED GALVANIZED SURFACES

A. Comply with ASTM A 780.

B. Repair using sprayed zinc coating, minimum dried film of 95% zinc by weight.

C. Clean, dry and remove oil, grease, and corrosion products from surfaces.

D. If the area to be reconditioned includes welds, first remove all flux residues and weld spatter by mechanical means that is, chipping, etc.

E. Wire brush clean the surface to be reconditioned in accordance with SSPC-SP3.

F. Extend surface preparation into the surrounding undamaged galvanized coating.

G. Apply the sprayed coating as soon as possible after surface preparation and before visible deterioration of the surface has occurred.

H. Provide the surface of the sprayed coating with uniform texture, free of lumps, coarse areas, and loosely adherent particles.

I. Provide dry mill thickness of 1 mil greater than specified for the hot-dipped galvanized material.

J. Take thickness measurements with either a magnetic or electromagnetic gage to ensure that the applied coating is as specified.

3.05 INSTALLATION OF ALUMINUM LADDERS

A. Secure ladders to adjacent construction with the clip angles attached to the stringer.

B. Install brackets as required for securing ladders, welded or bolted, to structural steel or built into masonry or concrete.

3.06 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

b. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete or in formed or core-drilled holes not less than 42 inches deep and 3/4 inch larger than O.D. of bollard. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

3.07 MEASUREMENT AND PAYMENT

A. No separate measurement or direct payment will be made for work under this Section, and the cost of same shall be included in the price bid for the item to which it pertains.

+++ END OF SECTION 05500 +++

SECTION 05510
METAL STAIRS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes requirements for Contractor designed galvanized steel and aluminum stair systems, including but not limited to landings, stairs stringers, stair treads, abrasive nosings, and railing.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below:

1. Section - 03300 Cast-In-Place Concrete

2. Section - 05531 Steel Grating

1.03 REFERENCES

A. The references listed below are a part of this section. 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.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
ACI 301	Standard Specification for Structural Concrete
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction
ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASTM A36	Carbon Structural Steel

Reference	Title
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123	Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193	Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications
ASTM A325	Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
ASTM A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653	Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process
ASTM A780	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
ASTM A924	Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A992	Structural Steel Shapes
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B211	Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM F436	Hardened Steel Washers
ASTM F594	Stainless Steel Nuts
AWS D1.1	Structural Welding Code - Steel

Reference	Title
AWS D1.2	Structural Welding Code - Aluminum
NAAMM AMP 510	Metal Stairs Manual
OSHA 29 CFR 1910.24	Fixed Industrial Stairs
IBC	International Building Code

1.04 DEFINITIONS

A. Galvanize: Hot dip galvanize per ASTM A123 or ASTM A153.

1.05 SUBMITTALS

A. Action Submittals:

1. Procedures: Section **01300 - Submittals**.

2. A copy of this specification with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations 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 signify compliance on the part of the Contractor with the specifications. Include 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, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. Manufacturer's product data.

5. Stair Design: Stair assemblies to be designed by the Contractor incorporating specified criteria, and employing a Professional Engineer currently registered in the State of Pennsylvania to perform the design engineering. Drawings and design calculations to be stamped and signed by the Professional Engineer.

6. Shop Drawings: Stair fabrication drawings showing layouts, connections to structural system, and anchoring details. Erection and installation drawings indicating thickness, type, grade, class of metal, coating system and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

7. Welding procedures and welder certificates and qualifications.

8. LEED Submittals - Submit a completed Green Building Materials Certification Form that lists permanently installed products and indicates material costs. Attach letter from manufacturer(s) describing product(s) contribution to LEED v4, including, but not limited to, the following:

    a. MR credit 2: Environmental Product Declarations (EPDs): Submit an Environmental Product Declaration.

    b. MR credit 3: Sourcing of Raw Materials: Indicate percentage by weight of pre-consumer and post-consumer recycled content. Indicate location of extraction and manufacture.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Fabricator shall be specialized in stair assemblies with a minimum of three years' experience.

B. Certificates:

1. Certified welding procedures and welding operators in accordance with AWS.

C. Regulatory Requirements:

1. Comply with International Building Code (IBC) and OSHA 29 CR 1910.24.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials to job site properly marked to identify the structure for which they are intended and at such intervals to insure uninterrupted progress of the work. Marking shall correspond to markings indicated on the shop drawings. Avoid damage during delivery and handling of fabrications.

B. Store all members off the ground using pallets, platforms, or other supports.

C. Do not store materials on the structure in a manner that might cause distortion or damage to the members or the supporting structure.

PART 2 - PRODUCTS

2.01 PERFORMANCE/DESIGN CRITERIA

A. Comply with IBC requirements, including but not limited to means of egress requirements, stair treads and riser configuration, handrail and guard layout and design, headroom, and stairway landing configuration.

B. Structural Requirements:

1. Dead Loads:

a. Designed for full dead-load plus the following live-load conditions applied individually or in combination in accordance with IBC.

2. Live Loads:

a. Metal stair assembly to carry a minimum uniform live load of 100 pounds per square foot (psf) of projected plan area.

b. Stair treads to be designed for a minimum concentrated load of 300 pounds on an area of 4 square inches.

c. An isolated concentrated load of 1000 pounds applied to framing members where it is most critical.

C. Deflections:

1. Limit live load deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

D. LEED Material Requirements:

1. MR credit 3: Sourcing of Raw Materials: Steel must contain minimum 25% total recycled content (post-consumer plus half pre-consumer recycled content).

2.02 MATERIALS

A. Materials for stair systems are specified in Table A.

Table A, Materials for Metal Stairs

Material	Specification
Steel	

Table A, Materials for Metal Stairs	
Material	Specification
Sheets, plates and shapes (except W shapes)	ASTM A36
Steel W shapes	ASTM A992
Pipe	ASTM A53, Grade B
Square/rectangular tubing	ASTM A500, Grade B
High strength bolts	ASTM A325 (Type 1)
Nuts	ASTM A563
Washers	ASTM F436
Aluminum	
Sheets and plates	ASTM B209, Type 6061-T6
Bars, flats and similar items	ASTM B211 or B221, Type 6061-T6
Shapes	ASTM B308, Type 6061-T6
Round tubing and pipe	ASTM B241, Type 6061-T6
Square and rectangular tubing	ASTM B221, Type 6063-T52
Pipe	ASTM B211 or B241, Type 6061-T6
Bolts, Stainless Steel	ASTM F593, Type 316
Nuts, Stainless Steel	ASTM F594, Type 316

B. Concrete:

1. Concrete for metal-pan concrete-filled treads to be Type D-1, Topping Concrete, in accordance with **Section 03300 - Cast-in-Place Concrete**.

2.03 FABRICATION

A. General:

1. Provide complete stair assemblies, including metal framing, stair treads, hangers, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and landings on supporting structure.

2. Conform to AISC or Aluminum Association standards as applicable.

3. Provide stairs of welded construction. Bolts may be used where welding is not practical.

4. Shop and field welding shall conform to the requirements of AISC, the Aluminum Design Manual, and applicable AWS procedures and specifications as required by the material being welded.

5. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt, tight, flush, and hairline. Remove burrs and weld splatter. Ease exposed edges to small uniform radius.

6. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be sub punched and reamed or shall be drilled.

7. Fabrication including cutting, drilling, punching, threading, and tapping required for fabrications or adjacent work shall be performed prior to hot-dip galvanizing.

8. Pre-assemble stair components in the shop to the greatest extent possible.

9. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

B. Stairs–Galvanized Steel:

1. Provide galvanized steel stairs complete with stringers, grating treads, landings, columns, guardrails, handrails, and necessary bolts and other fastenings. Hot dip galvanize steel stairs and accessories.

2. Fabricate stringers of structural steel channels. Provide closures for exposed ends of stringers. Construct landings of structural channel headers and miscellaneous framing members.

3. Grating Treads and Landings: Provide galvanized grating conforming to **Section 05531 – Steel Grating**. Fabricate grating treads with abrasive nosing and with steel angle or plate carrier at each end for stringer connections. Secure treads to stringers with bolts. Fabricate grating landings with nosing that matches grating treads. Provide toe-plates at open-sided edges of landing.

4. Provide railings for stairs and platforms in accordance with Section 05524.

C. Stairs–Aluminum:

1. Provide aluminum stairs complete with stringers, grating treads, landings, columns, guardrails, handrails, and necessary bolts and other fastenings.

2. Fabricate stringers of structural aluminum channels. Provide closures for exposed ends of stringers. Construct landings of structural channel headers and miscellaneous framing members.

3. Grating Treads and Landings: Provide aluminum grating for treads and platforms conforming to **Section 05530 – Aluminum Grating**. Fabricate grating treads with abrasive nosing and with angle or plate carrier at each end for stringer connections. Secure treads to stringers with bolts. Fabricate grating landings with nosing that matches grating treads. Provide toe-plates at open-sided edges of landing.

4. Provide railings for stairs and platforms in accordance with Section 05524.

D. Safety Nosings at Concrete Stairs:

1. Safety stair treads shall be 4 inches wide and manufactured by:

a. Safe T Metal Company Incorporated, Style AX

b. Wooster Products Incorporated, Alumogrit, Type 101

c. Approved Equal

2.04 FINISHES

A. Galvanizing:

1. Galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing in accordance with ASTM A123, ASTM A153, ASTM A653 or ASTM A924, Z275 G90, as applicable. Galvanize anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2. Repair damaged Zinc-Coated surfaces with galvanizing repair method and paint conforming to ASTM A780 or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Owner's Representative.

3. Safeguarding against warpage and distortion during hot dip galvanizing of steel in accordance with ASTM A384. Straighten items after galvanizing so that they are straight, free of racking and distortion.

B. Aluminum Surfaces:

1. Surface condition aluminum before finishes is applied. Remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks,

structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2. Aluminum finishes for unexposed sheet, plate and extrusions may have mill finish as fabricated.

3. Provide all other aluminum items with a standard mill finish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify measurements at the site. Include field dimensions in shop drawings.

B. Examine and accept existing conditions before beginning work.

3.02 INSTALLATION

A. Install items plumb, level and square, accurately fitted, and free from distortion or defects. Install rigid, substantial, and neat in appearance.

B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

D. Set steel stair baseplates on wedges, or shims. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

E. Railing: Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing required by design loads. Plumb posts in each direction.

F. Safety Nosings: Unless otherwise specified, safety stair nosing shall be installed on all concrete stairs. Nosing shall be secured to concrete with suitable anchors at 15 inches on centers and not more than 4 inches from the ends. 1/8-inch rubber tape, 1/8 inch thick, shall be provided at both ends and cut to fit shape of nosing prior to concrete placement.

G. Concrete: Pan-filled stairs to be constructed in accordance with Section 03300. Finish concrete with a “nonslip” finish with “very flat” tolerance as specified in ACI 301.

H. Fastening To Construction-In-Place: Provide anchorage devices and fasteners where necessary for fastening fabricated items to construction-in-place. Anchor bolts to be in accordance with Section 05095.

3.03 REPAIR/RESTORATION

A. Galvanized:

1. Maximum area to be repaired shall not be more than 1/2 of 1 percent of the surface area or 36 sq. in. per ton of piece weight, whichever is less. Damage in excess of this requirement shall be repaired by stripping and recoating entire piece.

2. Clean damaged areas to SSPC-SP5. Repair with zinc-rich paint in accordance with the manufacturer's instructions and with ASTM A780, Annex A2. Minimum thickness requirements shall be in accordance with ASTM A123.

3. Use zinc-rich repair paint. Acceptable manufacturer:

   a. LPS, Cold Galvanize

   b. ZRC Worldwide, ZRC Galvilite

   c. Approved Equal

3.04 FIELD QUALITY CONTROL

A. Electrolytic Protection: Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, or coatings. Aluminum in contact with concrete, grout, masonry, or dissimilar metals, shall be protected with a heavy coat of bituminous paint.

+++ END OF SECTION 05510 +++

SECTION 05524
COMPONENT ALUMINUM HANDRAIL

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, equipment, and materials required to furnish and install component aluminum handrail including all fittings, anchors, sleeves, and accessories, as shown on the drawings and specified herein.

B. Unless specifically designated on the Drawings, all handrails shall be component aluminum handrails meeting the requirements of this section of the specifications.

C. Handrails shall be furnished and installed where shown on the drawings.

D. Handrails shall be furnished with a toe board, except on the railings for stairs or where concrete curbs are provided.

1.02 DESIGN REQUIREMENTS

A. Component aluminum handrail system, including railings, posts, and gates, shall be designed and constructed in strict compliance with the requirements of OSHA and the Standard Building Code (SBCCI).

B. Component aluminum handrail system shall also be designed:

1. To withstand the working loads below with a minimum factor of safety of 1.5 based on the ultimate strength of the alloy used.

2. For a minimum safe working load of both of the following loads:

50 pounds per linear foot applied horizontally to the top rail and a vertical load of 100 pounds per foot applied simultaneously.

a. A 200-pound concentrated load applied in any direction at any point of the railing.

C. Splice joints shall be designed and constructed to provide strength equivalent to a straight section of pipe.

1.03 SUBMITTALS

A. Submit complete shop drawings and product data in accordance with the requirements of the General Conditions.

B. Submit, in accordance with the requirements of the General Conditions, manufacturer's recommendations and procedures for maintaining and repairing handrail, including methods, cleaning materials, refinishing materials, and precautions as to the use of materials which may be detrimental to handrail finish.

C. Submit certifications as required in Paragraph QUALITY ASSURANCE below.

1.04 STORAGE AND PROTECTION

A. Keep handling to a minimum and maintain protective covering on handrail until the work is complete. The Contractor shall take care in handling the rails during shipment, unloading, erection, and during construction to prevent damage to the railing.

B. 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.

1.05 QUALITY ASSURANCE

A. The Contractor shall provide the Engineer with written certification that the aluminum handrail and accessories are designed and manufactured in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the aluminum handrail supplier may be considered evidence of compliance, provided such tests are performed in accordance with the appropriate ASTM Testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on certified sample of handrail stock. Cost of this testing shall be borne by the Contractor.

B. Furnish a manufacturer's inspection certificate stating that the handrail system as installed meets the requirements of these Specifications and the Manufacturer's written instructions. Contractor shall correct all inadequacies found during the inspection process.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Component aluminum handrail system shall be manufactured by Thompson Fabricating Company of Birmingham, Alabama, Alumagard of Denver, Colorado, or Hollaender Manufacturing of Cincinnati, Ohio.

2.02 MATERIALS AND CONSTRUCTION

A. Railing: Railing shall be an extruded tube manufactured from an aluminum alloy in accordance with ASTM B221, Alloy 6105, Temper T5. Railing shall have a minimum outside diameter of 1.90 inches. Railings shall have a minimum wall thickness of 0.145 inch.

B. Posts:

1. Posts shall be an extruded tube manufactured from an aluminum alloy in accordance with ASTM B221, Alloy 6105, Temper T5. Posts shall have a minimum outside diameter of 1.90 inches. Posts shall have a minimum wall thickness of 0.20 inch.
2. The posts shall have an internal reinforcing dowel to assist in the transfer of the loadings from the post to the base. The dowel length shall extend 12 inches (or longer if required by the manufacturer to meet criteria) above the walking surface and recessed 1/4 inch from bottom of post and shall be tack welded in two locations to secure dowel in the post.

C. Expansion Anchor Bolts: Expansion anchor bolts shall be designed with a safety factor of 4 on ultimate withdrawal and shear in 4,000 psi concrete. Expansion bolts shall be spaced a minimum of 10d apart with 5d minimum edge distance without reduction of withdrawal and shear values used in calculations. Expansion bolts shall be stainless steel of wedge type construction, as specified in **Section 05500 - Miscellaneous Metals,** of these Specifications.

D. Fasteners: Handrail system shall be assembled using components that make rigid joints. Railing joints shall be assembled using stainless steel set screws. Other joints shall be assembled using stainless steel fasteners. No pop riveted, glued systems, or welded railing will be allowed.

E. Anodizing: All railing and posts, and their components, shall be anodized in accordance with Aluminum Association Standard AA-M10-C22-A41 on all exposed surfaces.

F. Brackets and Bases:

1. Side mount brackets shall be nonwelded extrusions attached to posts with stainless steel set screws.

2. Top mounted bases shall be al-mag castings, anodized. Castings shall be permanent mold or die cast. If bases are sand castings or machined, they shall be finished smooth prior to anodizing to approximate the finish of permanent molds or die cast satisfactory to the Engineer. Casings shall be attached to the post with stainless steel set screws and pressure plate. Cast bases shall slip over the outside of the pipe post so that the pipe and integral internal dowel may function together in transferring the load to the base flange. Aluminum bases of welded construction are not acceptable.

G. Handrail system shall provide for draining of entrapped water from the railing systems by minimum 15/64-inch diameter weep holes or other approved means.

H. Toeboards: Toeboards shall be of the same material and finish as the rails and posts. Toeboards shall be extruded design that clamp to the post to allow expansion and contraction. Toeboards shall have a minimum height of 4 inches.

I. Gates: Gates shall be of the same material and finish as the rails and posts. Gates shall be equipped with a spring to assist in closing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. **General**: Handrail system shall be assembled and installed in strict compliance with the manufacturer's instructions. Maximum post spacing shall be 6 feet 0 inch. The handrail manufacturer may use less than 6 feet 0 inch if their system requires closer spacing to meet design criteria.

B. Shop Assembly: Handrail manufacturer shall shop assemble the handrail in shippable modules not to exceed 30 feet in length. Field manufacturing of handrail modules will not be permitted.

C. Set handrail modules plumb within 1/8 inch of vertical and align horizontally to

within 1/8 inch in 12 feet. Set stair rail modules plumb within 1/8 inch of vertical and set rake rails aligned horizontally to 1/8 inch in 12 feet.

D. Handrail mounting shall be embedded, top mounting base, or side mounted. Install expansion bolts to proper depth to develop full withdrawal and shear values. Check all fasteners and bolts in base connections and splices for tightness.

E. Handrail components coming into contact with concrete or dissimilar metals shall be coated with bituminous protective coating or installed with a vinyl isolation gasket.

F. Splice joints to facilitate removal of pipe railing shall be provided at all intersections, changes in direction, or at intervals not to exceed 30 feet in straight runs of railing.

G. Adequate provisions for expansion and contraction shall be incorporated in the rails. Expansion joints shall be placed at 60-foot intervals. Handrail shall not be continuous across the concrete expansions joints.

H. Open rail ends shall be closed by terminal end fittings.

I. Gates shall be provided in all handrail openings. Chains will not be permitted at handrail openings.

J. Toeboards shall be shipped loose and field assembled to posts with clamps. The attaching system shall be such that contraction and expansion can occur while maintaining a straight line. Toeboards shall be set so that the bottom of the toeboard is within 1/4 inch above the walking surface.

K. All defective, damaged, or otherwise improperly installed handrail shall be removed and replaced with material that satisfies the requirements of this Section.

3.02 CLEANING

A. Following installation, aluminum handrail shall be cleaned using soap and clean water. Acid solutions, steel wool, or harsh abrasives shall not be used. If stains remain after cleaning, remove finish and restore in accordance with the manufacturer's written instructions to the satisfaction of the Engineer.

+++ END OF SECTION 05524 +++

SECTION 05530
ALUMINUM GRATING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges, 14th Edition, 1989.

2. American Society for Testing and Materials (ASTM):

a. A36-90, Standard Specification for Structural Steel.

b. A123-89a, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

c. A153-82, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware (R 1987).

d. A167-91, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

e. A193-90a, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

f. A194-91, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

g. A307-91, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

h. A525-91a, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

i. A569/A569M-91a, Standard Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.

j. B221-91, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

k. F844-90, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

3. National Association of Architectural Metal Manufacturers (NAAMM):

a. ANSI MBG 531-88, Metal Bar Grating Manual.

b. ANSI MBG 532-88, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Shop Drawings:

1. Grating: Show dimensions, weight, and size, and location of connections to adjacent grating, supports, and other Work.

2. Grating Anchorage: Show structural calculations and details of anchorage to supports to prevent displacement from traffic impact.

3. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.

4. Catalog information and catalog cuts.

5. Manufacturer's specifications, to include coatings.

B. Quality Control Submittals:

1. Special handling and storage requirements.

2. Installation instructions.

3. Factory test reports.

4. Manufacturer's Certification of Compliance for specified products.

5. Written Test Report that swaged crossbars, if used on grating, meet the requirements of the specified test and additional requirements of these Specifications.

1.03 PREPARATION FOR SHIPMENT

A. Insofar as is practical, factory assemble items provided.

B. Package and clearly tag parts and assemblies that are of necessity shipped unassembled and protect the materials from damage, and facilitate identification and final assembly in the field.

PART 2 - PRODUCTS

2.01 FOOT TRAFFIC GRATING

A. Design:

1. Uniform Service Load: 200 psf minimum, unless otherwise shown.

2. Maximum Deflection: 1/4 inch, unless otherwise shown.

3. Space bearing bars at 1-3/16-inch center-to-center.

4. Banding: 3/16-inch minimum.

B. Material:

1. Aluminum Bar Type Grating:

a. Press-locked rectangular design, as manufactured by IKG/Borden, Clark, NJ; IKG/Borden Type B or Type F.

b. Swage locked aluminum grating, rectangular bar type, as manufactured by:

(1) IKG/Borden, Clark, NJ; IKG/Borden Type BS or Type FS.

(2) Seidelhuber Metal Products Inc., San Carlos CA; Type A-2.

(3) Ohio Gratings, Inc., Canton, OH; Aluminum Flush Top, Type 19SGF2.

(4) Klemp Corp., Chicago, IL; Type KRP.

2. Stair Treads:

a. Material and Type: Same as grating material and grating type as furnished for connecting walkway or work surface.

b. Nosings: Integral ribbing and serrated edge on one long axis of tread or nonslip, abrasive on each tread along one long edge.

c. Carrier Plate or Angle: Furnish at each end for connection to stair stringers.

d. Manufacturers: Same as for grating.

2.02 ACCESSORIES

A. Anchor Bolts and Nuts:

1. Carbon Steel: ASTM A307-91 or A36-90.

2. Stainless Steel: ASTM A193-90a and ASTM A194-91, Type 316.

3. Galvanized Steel Bolts and Nuts: ASTM A153-82, zinc coating for ASTM A307-91 or A36-90.

B. Flat Washers (Unhardened): ASTM F844-90; use ASTM A153-82 for zinc coating.

C. Removable Fastener Clips and Bolts:

1. Removable from above grating walkway surface.

2. Hat Bracket: Type 304 stainless steel.

3. Bolt: Type 316 stainless steel.

4. Cast iron, galvanized body.

5. Manufacturer and Product: Struct-Fast, Wellesley Hills, MA; Gratefast.

C. Partially Removable Anchor:

1. Bolt: Threaded stud, Type 316 stainless steel.

a. Manufacturer: Nelson Stud Welding Co., Lorain, OH.

2. Hat Bracket: Type 304 stainless steel.

a. Manufacturer: STRUCT-FAST, Wellesley Hills, MA.

2.03 FABRICATION

A. General:

1. Exposed Surfaces: Smooth finish and sharp, well-defined lines.

2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in a neat, substantial manner.

3. Conceal fastenings where practical.

4. Drill metalwork and countersink holes as required for attaching hardware or other materials.

5. Weld Connections: Not permitted on grating except at banding bars.

B. Design:

1. Field measure areas to receive grating, verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.

2. Section Length: Sufficient to prevent its 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.

3. Minimum Bearing: ANSI/NAAMM MBG 531-88.

4. Metal Crossbar Spacing: 4-inch maximum, unless otherwise shown or specified.

5. Crossbars: Flush with top of main bar and extend downward a minimum of 50 percent of the main bar depth.

a. Swaged Crossbars:

(1) Within 1/4-inch of top of grating with 1/2-inch minimum vertical dimension after swaging, and minimum before swaging dimension of 5/16-inch square.

(2) Crossbar Dimension After Swaging: Minimum 1/8-inch wider than the opening at minimum of two corners at each side of each square opening in main bar.

(3) Crossbars may be a special extruded shape so that after swaging the top will be flat, 3/16 inches wide and will be flush with the top surface of the bearing bars for a minimum of 5/8 inches at center between bearing bars.

(4) Flush crossbar meeting all of the above except that after swaging shall overlap one corner by a minimum of 1/8 inch. A sample of one bearing bar and one crossbar shall be tested by holding the bearing bar and pulling on the crossbar. The crossbar to bearing bar shall sustain a minimum of 300 pounds without pullout of the bearing bar.

(5) Tightly fit main bars and crossbars allowing no differential movement.

6.Do not use weld type crossbars.

7. Banding: Same material as grating; ANSI/NAAMM MBG 531-88 and ANSI/NAAMM MBG 532-88.

8. Furnish stainless steel Type 316 threaded anchor studs, as fasteners for grating attachment to metal supports either not embedded or partially embedded in concrete, as manufactured by Nelson Studs Welding Co., Lorain, OH.

C. Supports:

1. Seat angles and beams where shown:

a. Same material as rectangular bar grating.

b. Extruded aluminum frame with slot for recessed grating clips, as manufactured by Thompson Fabricating Co., for aluminum I-Bar type grating.

2. Coordinate dimensions and fabrication with grating to be supported.

3. Coordinate dimensions with increased depth due to serrations.

4. Welded Frames With Anchors: Continuously welded.

D. Slip-Resistant Surface:

1. Rectangular Aluminum Bar Grating: As manufactured by:

a. IKG/Borden, Clark, NJ; EZ Weldslip-Resistant Coating.

b. Seidelhuber Metal Products, Inc., Hayward, CA; Safety Grit Non-Slip System.

c. Ohio Gratings, Inc., Canton, OH with "Slip-Not" Safety Surface manufactured by W.S. Molnar Co., Detroit, MI.

2. I-Bar grating aluminum shall incorporate a striated antiskid walking surface produced during the extrusion process, as manufactured by:

a. IKG/Borden, Clark, NJ.

b. Seidelhuber Metal Products, Inc., Hayward, CA.

c. Klemp Corp., Chicago, IL.

E. Aluminum:

1. ASTM B221-91 extruded shapes.

2. Fabricate as shown and in accordance with manufacturer's recommendations.

3. Grind smooth sheared edges exposed in the finished work.

4. Swage crossbars, if used, with equipment strong enough to deform crossbars.

5. Eliminate any loose crossbar intersections on swaged grating.

F. Foot Traffic Grating: Any single grating section, individual plank, or plank assembly shall be not less than 1-foot 6 inches or greater than 3 feet 0-inch in width or weigh more than 150 pounds.

PART 3 - EXECUTION

3.01 PREPARATION

A. Electrolytic Protection:

1. Aluminum in contact with dissimilar metals, other than stainless steel, and embedded or in contact with masonry, grout, and

concrete, protect surfaces as specified in Section 09900 -Painting, System No. 27.

2. Allow paint to dry before installation of the material.

3.02 INSTALLATION

A. Install supports such that grating sections have a solid bearing on both ends, and that rock and wobble grating movement does not occur under designed traffic loading.

B. Install plumb or level as applicable.

C. Install welded frames with anchors to straight plane without offsets.

D. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

E. Use stainless steel anchors and accessories with aluminum gratings.

F. Completed installation shall be rigid and neat in appearance.

G. Commercially Manufactured Products:

1. Install in accordance with manufacturer's recommendations.

2. Secure grating to support members with fasteners.

3. Welding is not permitted.

4. Fasteners: Field locate and install.

5. Permit each grating section or plank style grating assembly to be easily removed and replaced.

H. Protect painted surfaces during installation.

I. Should coating become marred, prepare and touch up surface in accordance with paint manufacturer's instructions.

+++ END OF SECTION 05530 +++

SECTION 05531
STEEL GRATING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall furnish all labor, materials, equipment and incidentals required to provide steel grating and frames as shown and specified.

2. Grating shall be an open grid of carbon steel bars consisting of plain bearing bars with round or twisted cross bars. Grating shall be electro-pressure welded.

1.02 SUBMITTALS

A. 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. Drawings for the fabrication and erection of all work. include plans, elevations, and details of sections and connections. Show anchorage and accessory items.

2. Setting drawings and templates for location and installation of anchorage devices.

3. Manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.

1.03 QUALITY ASSURANCE

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

1. ASTM A 569, Steel, Carbon (0.15 Maximum, percent), Hot-Rolled Sheet and Strip, Commercial Quality.

2. NAAMM, Metal Bar Grating Manual.

B. Field Measurements:

1. Take field measurements prior to preparation of Shop Drawings and

fabrication where required, to ensure proper fitting of the Work.

PART 2 - PRODUCTS

2.01 PERFORMANCE CRITERIA

A. The Contractor shall furnish grating, conforming to the following criteria:

1. Design Loads: Uniform live load, or a concentrated load on any area 24 inches square, whichever gives the greatest stresses.

Live load	Concentrated load
300 psf	2000 lbs.

2. Maximum Clear Span Deflection: 1/180 of span.

3. Maximum Fiber Stress: 18,000 psi.

4. Minimum Size of Members:

   a. Minimum size of bearing bars shall be within standard mill tolerance of that shown on the Load Tables in the NAMMM Manual for applicable loading and deflection requirements. In no case shall their depth be less than 3/4 inch.

   b. Minimum dimensions of cross bars shall be as shown on the tables of Minimum Standard Cross Bars and Connecting Bars in the NAAMM Manual.

5. Banding bar thickness shall be the same as the bearing bar to which it is attached.

2.02 MATERIALS

A. Bearing bars, banding bars and cross bars: Carbon steel conforming to ASTM A 569.

2.03 FABRICATION

A. Use materials of the minimum size and thickness as specified above, unless otherwise shown. Work to the dimensions shown on approved Shop Drawings.

B. Grating shall be as shown and shall comply with the NAMM Manual, except as specified herein.

1. All tolerances shall be within the limits shown on the details for manufacturing tolerances in the Manual.

2. Banding, nosings and carriers shall be attached by welding, as shown on the details for Welding Standards in the Manual.

3. All welding shall comply with the recommendations of ASTM A 385. Welds shall not be ground, unless otherwise shown or specified.

4. Traffic surface shall be plain.

C. Product and Manufacturer:
   1. Irving Gripweld by IKG Industries, Division of Harsco Corp.

   2. Blaw-knox Welded Grating supplied by Fontana Metal Sales Corp.

   3. Or equal.

D. Type of Finish: Shop applied epoxy paint as specified in **Section 09900 - Painting.**

E. Provide removable grating sections where shown, specified or otherwise required. They shall have end banding bars for each panel. For grating having bearing bars at 1-3/16 inch centers or greater, provide 4 saddle clip anchors designed to fit over 2 bearing bars, and 4 stud bolts with washers and nuts, unless otherwise shown or specified. For bearing bars spacing less than 1-3/16 inch centers, provide anchors in accordance with manufacturer's recommendations.

F. At concrete openings, support and band grating as shown on detail for Support and Banding of Trench Grating in the NAAMM Manual. Provide steel angle frames having mitered corners and welded joints. Grind exposed joints smooth. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected to assure flush fit.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Fastening to In-Place Construction:

   1. Use anchorage devices and stainless steel fasteners to secure grating to supporting members or prepared openings, as recommended by the manufacturer.

B. Cutting, Fitting and Placement:

1. Perform all cutting, drilling, fitting and welding required for installation. Set the Work accurately in location, alignment and elevation, plumb, level and free of rack. Do not use wedges or shimming devices.

3.02 TOUCH-UP

A. Touch-up shop coating, damaged in the shop or during field erection, by recoating with same material.

3.03 ADJUSTMENT AND CLEANING

A. Grating shall be levelled and fastened securely in place so that no warping, "rocking" panels, or offsets exist, and so that top surface is flush with adjacent floor surfaces.

B. Remove all stains, cement droppings, oils, dirt, grease, or other foreign matter and leave grating in clean, first class condition.

+++ END OF SECTION 05531 +++

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 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.

B. Section includes:

1. Surface preparation to receive finishes.

2. Painting, staining, or otherwise finishing of all surfaces.

C. Related Work Specified Elsewhere

1. Section 05500, Miscellaneous Metal.

1.02 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.

1.03 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 **OWNER**.

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.

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.

1.04 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 **OWNER** 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 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.

1.05 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

2.01 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.

2.02 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.

2.03 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.

E. All paints, finishes, stains, primers, shellacs, sealants and coatings shall comply with the requirement of LEED 2009 IEQ Credit 4.2: Low-Emitting Materials - Paintings and Coatings.

2.04 COLORS

A. The **OWNER** 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.

B. Review Finish Schedule for color selections that may have already been made by the **OWNER**.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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 County inspector 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. Ferrous Metals: Standards for the surface preparation of ferrous metals required in the Material Schedules are the standards of the Steel Structures Painting Council (SSPC, SP-1 through SP-10). Inspection of these surfaces will be evaluated by field comparison with visual comparator panels. These panels shall be securely wrapped in clear plastic and sealed to protect them from deterioration and marring.

E. Galvanized metal: Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

F. Aluminum: Sand to remove oxides. Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

G. Cast-In-Place Concrete Surfaces: No Coatings Required.

3.05 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 **OWNER**. 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.

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 County inspector.

E. Inspection: The County inspector 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 County inspector, any painting work found to be defective or applied under adverse conditions.

3.06 PAINTING SCHEDULE

A. Paint construction on roof top; include mechanical and electrical equipment except as indicated below.

1. None.

B. Surfaces not requiring painting or coating:

1. Face brick.

2. Cast-in-place concrete and Precast concrete.

3. EIFS.

4. Prefinished surfaces and items.

5. Concealed ductwork, conduit, and piping.

C. The Sample Painting Schedule below is an example schedule. **CONTRACTOR** shall submit a final schedule with the paint submittal for the painting systems to be applied to the various surfaces.

SAMPLE PAINT SUBMITTAL SCHEDULE

System	Specification	Item	Surface Prep	Primer	Finish & Touch Up	Color
A	SS 5500	Misc. Metals	SSPC 6 for Non-Immersion	Tnemec 90-97	2 Coats of 89 Series for Non-Immersion at 4-6.0 mils	Warm Gray M3759
B	SS 5500	Misc. Metals	SSPC 10 of Immersion	Not Required	2 Coats of 78 Series for Immersion at 4-6.0 mils	Gray
C	SS 5500	Roof Hatch	Mill Finish Aluminum	Not Required	Not Required	Not Required

PAINTING SCHEDULE

Surfaces	Substrate Materials	Paint Material/Schedule
All Other Listed Metal Surfaces, Except Dumpsters	Galvanized Metal	141*
	Ferrous Metal	141

* Galvanized metal shall not be painted unless called for on the Finish Schedule.

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

SHERWIN-WILLIAMS

PRIMER: ZINC CLAD III - 3.0 MILS*

FIRST COAT: MACROPOXY 646-100 FC - 4.0 MILS*

SECOND COAT: ACROLON 100 URETHANE - 3.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 10.0 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. Koppers.

   b. Tnemec.

PIPE AND EQUIPMENT COLORS

STENCIL WORDING	SYMBOL	COLOR	LETTERS & ARROW
Force Main	FM	TBD by **OWNER**	Yes And Direction of Flow
In-Plant Exposed Process Piping	SS	TBD by **OWNER**	Yes And Direction of Flow
Potable Water	PW	TBD by **OWNER**	Yes
Non-Potable Water	NPW	TBD by **OWNER**	Yes
Compressed Air	AIR	SW4084- SAFETY YELLOW	Yes
Air Vacuum	ARV	TBD by **OWNER**	Yes
Vent	V	TBD by **OWNER**	Yes

END OF SECTION

SECTION 11000
GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 – GENERAL

1.01 SCOPE:

A. 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.

B. Equipment Lists: Equipment lists, presented in these specifications and as specified on the Drawings, are included for the convenience of the **Owner**'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.

1.02 QUALITY ASSURANCE

A. Arrangement: The arrangement of equipment shown on the Drawings is based upon information available to the **Owner** 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.

B. 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
ANSI B18.2.2 87	Square and Hex Nuts
ANSI S2.19	Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

C. Unit Responsibility: The unit responsibility for equipment systems made up of two or more components shall be provided in accordance with **Section 01600 - General Material and Equipment Requirements.**

D. 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 - General Material and Equipment Requirements,** 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.

E. 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

2. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data.

PART 2 – PRODUCTS

2.01 FLANGES AND PIPE THREADS

A. 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.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

C. 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.

2.02 BEARINGS

A. 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.

B. 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.

C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

D. 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.

2.03 V BELT ASSEMBLIES

A. 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.

B. 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.

C. 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.

2.04 PUMP SHAFT SEALS

A. 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.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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.

G. 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 11000-2.04.B for the applicable pump and operating conditions.

H. 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.

I. 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.

2.05 COUPLINGS

A. 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.

B. 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.

2.06 GUARDS

A. 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.

2.07 CAUTION SIGNS

A. 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.

2.08 GAGE TAPS, TEST PLUGS AND GAGES

A. 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.

2.09 NAMEPLATES

A. 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

A. 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 **Owner**'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 **Owner** 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

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05095. Unless otherwise stated in the detailed specification, anchor bolt materials shall conform to the provisions of Section 05095.

2.12 SPARE PARTS

A. 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

A. 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 11000

SECTION 11240
CHEMICAL METERING PUMPS

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this section includes furnishing all labor, materials, and equipment required to install, test, and place into satisfactory operation skid mounted positive displacement, peristaltic hose type pumps with enclosures and appurtenances as specified herein and as shown on the drawings.

B. The following is a list of standards which may be referenced in this Section:

1. Hydraulic Institute Standards
    a. HI 9.1-9.5 (2000) Pumps - General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation.
    b. HI ANSI/HI 7.1-7.5 - (2017) Controlled-Volume Metering Pumps American National Standard for Nomenclature, Definitions, Application, and Operation - B115

2. Institute of Electrical and Electronics Engineers (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

3. ASTM D1785 - (2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120

4. NFPA 70 - (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

5. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

C. Not Used.

1.02 EQUIPMENT AND COMPONENT NUMBERS

A. (Not Used)

1.03 DEFINITIONS

Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.04 SUBMITTALS

A. Submit shop drawings and engineering data in accordance with the requirements of Section 01300 of these Specifications.

B. Additional shop drawing data required:

1. Make, model, weight, and horsepower of each equipment assembly.

2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

3. Performance data on pumps, including curves showing flow rate versus pump stroke setting (in percent) at specified maximum speed in strokes per minute.

4. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, required backpressure valve setting, pumped chemical characteristics (including but not limited to specific gravity and viscosity), pipe connection sizes, stroke rate, materials, testing requirements, intermediate fluid type, and appurtenances to be provided with pumps.

5. Detailed dimensional drawings for pump and driver, accessories, skids, and piping connection sizes and locations.

6. HDPE skid cabinet and heating information.

7. Power and control wiring diagrams, including terminals and numbers. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.

8. Manufacturer's materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.

9. Factory finish system.

C. Information Submittals:

1. Manufacturer to certify material selection of provided pump and valves for the chemicals to be used.

2. Factory Functional and Performance Test Reports.

3. Manufacturer's Certification of Compliance that factory finish system is identical to requirements specified herein.

4. Special shipping, storage and protection, and handling instructions.

5. Manufacturer's printed installation instructions.

6. Manufacturer's Certificate of Proper Installation in accordance with Division 1, General Requirements.

7. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

8. List special tools, materials, and supplies furnished with equipment for use prior to and during start-up and for future maintenance.

9. Operation and Maintenance Manual.

1.05 EXTRA MATERIALS

A. Furnish for each set of pumps that has identical chemical service and pumping characteristics:

1. One pressure relief, anti-siphon, and diaphragm back pressure control valve (per pump).

2. One pulsation dampener on discharge side of pump.

3. Calibration column per set of pumps.

4. One complete set of any special tools required to dismantle pump.

5. Four sets of ball check valves.

B. Not used.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Pumps and accessories shall be stored and protected in accordance with the manufacturer's recommendations. Pumps shall not be stored outside or exposed to the weather.

B. Pumps shall be completely drained prior to shipment. Suction and discharge ports shall be provided with plastic plugs. Each pump shall be secured to a wooden skid and crated to facilitate handling and storage.

PART 2 - PRODUCTS

2.01 GENERAL

A. Each set of pumps shall be provided on a skid in an outdoor rated HDPE skid enclosure, except where single pumps skids are shown on the Drawings, or specified herein, with the second pump provided loose for storage. Skids shall be manufactured of polypropylene or a material suitable for exposure to chemicals being pumped. Metallic skids are not allowed.

B. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

C. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

D. All pumps, motors, and accessories including, as listed in Paragraph 2.08, Pump Skids, shall be factory mounted on skid and shipped to jobsite assembled.

2.02 MANUFACTURERS

Acceptable manufacturers included the following:

A. Eco-Tech Inc. or equal.

2.03 QUALITY ASSURANCE

To ensure all equipment required for installation of feed pumps, controls, and other accessories is properly coordinated and will function in accordance with intent of these Specifications, obtain all equipment specified under this

Section, from a single supplier in whom responsibility for proper selection of all equipment, regardless of manufacturer, as an integrated and coordinated system is vested. Intent of this paragraph is to establish unit responsibility for all equipment through feed pump equipment supplier. Use of work "responsibility" relating to feed pump equipment supplier is not intended to relieve ultimate responsibility for equipment coordination, installation, operation, and guarantee.

2.10 SOURCE QUALITY CONTROL

A. Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test one equipment actually furnished.

C. Factory Test Report: Include test data sheets.

D. Function Test: Perform manufacturer's standard test on equipment.

2.04 CONTROLLED VOLUME SKID MOUNTED CHEMICAL PUMPS

A. Pumps: Pumps shall be positive displacement, peristaltic type. Each pump must be capable of delivering chemical solution at any rate from the minimum flow rate to the maximum flow rate and be capable of continuous operation at rated capacity. Provide in a configuration as simple as practicable to provide equipment isolation, bypass and reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

Component	Parameter	Liquid Sodium Hypochlorite	Liquid Sodium Bisulfite	Liquid Ferric Chloride
Chemical	Purpose	disinfection	dechlorination	enhanced TSS or P removal[1]
	Feed Point(s)	CCT influent	CCT effluent	AB influent and clarifier influent
	Chemical Formula	NaOCl	$NaHSO_3$	$FeCl_3$
	Chemical Concentration (%)	12.5	40	40
	Chemical Specific Gravity	1.2	1.34	1.42
	Chemical Density (lb/gal)	10.01	11.16	11.84
	Chemical pH	n/a	n/a	n/a
	Chemical Freezing Temperature (°F)	-3 to -14	45	30
	Exposure	Outside	Outside	Outside
	Minimum Ambient Air Temperature	11 °F	11 °F	11 °F
	Insulation and Heat Tracing	Yes	Yes	Yes

Component	Parameter	Liquid Sodium Hypochlorite	Liquid Sodium Bisulfite	Liquid Ferric Chloride
Metering Pumps @0.2 MGD	Suction Pipe Size	1"	1"	1"
	Discharge Pipe Size	¾"	¾"	¾"
	Flow Rate Range, gph	0.8 to 2.5	0.007 to 0.22	0.04 to 1.19
	No. of Pumps	2	2	2
	Point (1) of Application	1	1	1
	Application Point	Influent CCT	Effluent CCT	Influent Clarifiers
	Pump Horsepower	0.25	0.25	0.25
Note 1 – Ferric Chloride dose is based on removing effluent P = 5 mg/L				

B. Nameplate: Each pump shall include a nameplate secured to each pump containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

C. Pump Housing: Metering pump housing shall be of chemically resistant glass fiber reinforced thermoplastic. All exposed fasteners shall be stainless steel.

D. Pump Roller: Pump shall be of a single roller design. Compression shoes or multiple rollers are not allowed.

E. Pump Lubricant: Hose pump lubricant shall be an NSF listed, food-grade, glycerin based lubricant. Pump shall not require more than 4.5 fl oz of lubricant for 10 mm hose.

F. Positive Flow: Positive flow shall be ensured by a minimum of two check valves. Check valves shall be ball type with balls seating on combination valve seat and seal ring. Valve seat and seal ring shall be renewable by replacing only the combination seat-seal ring.

G. Leak Detection: Pump fluid (lubricant) high level leak sensor shall be installed on each pump to detect an internal pump hose leak.

H. Calibration Cylinder: Graduated in 0.01-gallon increments, constructed of clear polypropylene and PVC with ball type shutoff valve sized by manufacturer. Provide calibration column on each skid. (Note: Calibrated cylinders for ferric chloride shall be constructed of glass with Teflon seals.)

I. Skids: Each skid shall consist of a shop assembled skid, duplex variable speed peristaltic hose pumps including gauges, pressure relief valves, anti-siphon valves, calibration columns (one per skid), ball valves and user interface/ controller. Pump head, rotors, hose, ball check valves, and fittings and connections at pump head shall be in accordance with attached data sheets. All components mounted on skid shall be easily accessible from the front of the skid.

2.05 POWER AND CONTROL REQUIREMENTS

A. Electric motors must be of sufficient capacity to operate the chemical metering equipment under all operating conditions without exceeding their rated nameplate current or power, or their specified temperature limits. Provide motors having starting characteristics and ruggedness necessary under the actual conditions of operations or clean-up procedures used in the areas where they are located. Alternating current motors with power rating of 1/3 hp or less must be 115 volts, single-phase, 60-Hz service; motors with power rating in excess of 1/3 hp must be 460 volts, three-phase, 60-Hz service.

B. Provide tubing to connect to adjacent piping.

C. Pump shall have integral control unit with manual START/STOP and stroke adjustment (manual stroke adjustment on motor driven pumps). Pump shall be supplied with manufacturer supplied cable and remote termination box. The following control signals/control options shall be available for the pump via the termination box:

1. Local SPEED indicator.

2. Local off REMOTE.

3. Pump RUN command dry contact input.

4. Pump SPEED command 4 to 20 mA analog input.

5. Pump SPEED/STROKE feedback 4 to 20 mA analog output.

6. Fault alarm as dry contact output.

D. Pump Control:

1. Manual Stroke Adjustment: Provide manual stroke length adjustment through adjustment knob on unit that provides adjustment accuracy of 1 percent. Adjustment shall be self-locking, and shall be operable whether or not pump is running.
2. Adjustable Speed (Stroke Frequency) Adjustment: Provide adjustable speed operation of pump using AC VSD drive. Coordinate pump motor type with drive unit provided.

2.06 PULSATION DAMPENERS

A. Single-diaphragm type mounted on discharge piping. Size for pump

stroke volume. Body material and diaphragm material shall be equal to specified materials in the supplement tables for the specified chemical.

B. Air charging valve and pressure gauge.

2.11 FACTORY FINISHING

Finish shall be suitable for specified chemical service and in accordance with **Section 09900 - Painting** .

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05501, Metal Fabrications and Castings.

3.02 FIELD FINISHING

(Not Used. Not Applicable)

3.03 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Alignment and Functional Tests:

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

2. Functional Tests: After installation of each controlled volume pump, carry out functional operating tests as to assure that the chemical metering installation operates properly. Test pumps to demonstrate that the pumps are capable of operating without vibration or leakage. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests. Submit reports of all tests in hardcopy form prior to final acceptance of the installation. Show all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

C. Performance Test:

1. Perform under actual or approved simulated operating conditions. Perform testing at the pump's maximum flow rate and at half the flow rate. Demonstrate testing while controlled and operated in all feasible modes with the pumps operated singly and in unison. Plot the response of each pump on curves for the various operating pressures encountered and the results compare to the curves shown on the manufacturer's published pump data. Complete the **Chemical Pump Performance Test Form** at the end of this specification.

2. Test pumps by filling the calibration column with chemical and measuring the outage, with all other equipment valved off. Record the time, volume and pumping pressures.

3. Test for a continuous 3-hour period without malfunction.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at site or classroom designated by **Owner**, for minimum person-days listed below, travel time excluded:

1. Three (3) trips, one (1) day/trip (7 hrs/day), for installation assistance and inspection.

2. Two (2) trips, one (1) day/trip (7 hrs/day), for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

3. One (1) trip, one (1) day/trip (7 hrs/day) for facility start-up.

4. One (1) trip, one (1) day/trip (7 hrs/day) for post-start-up training of Owner's personnel.

B. See **Section 01640 - Manufacturers' Services** and **Section 01650 – Installation, Testing, and Startup Services**.

3.05 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Submit complete copies of operating and maintenance instructions outlining the step-by-step procedures required for system startup, operation and shutdown, and routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides.

B. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Also include in the instructions as-built drawings of the piping layout, equipment layout, simplified wiring and control diagrams of the system as installed, and flow diagrams.

3.06 TEST REPORT(S)

A. Test report(s) listed below, following "END OF SECTION" are part of these Specifications.

1. Metering Pump Data Sheet

END OF SECTION 11240

11240-01 - CHEMICAL PUMP PERFORMANCE TEST FORM

Tag Numbers: _____

Pump Name: _____

Manufacturer and Model Number: _

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): _____

Pumping Temperature (Fahrenheit): Normal: _____ Max:____ Min____

Specific Gravity at ___ Degrees F: _____

Liquid pH: _____

Suction Pressure Minimum (psig): _____

Location (indoor/outdoor): Outdoor__

PERFORMANCE REQUIREMENTS

Capacity Range (US gph): _____ to _____

Maximum Discharge Pressure (psig): ____

Max Pump Speed at Rated Capacity (RPM): ____

Normal Operating Pressure (psig): _

DESIGN AND MATERIALS

Pump Type: Peristaltic___

Pump Speed Control: Variable

Tube Material: _____

Fluid Connection Port Material: _____

Fluid Connectors Material: _____

Fluid Connection Seals Material: _____

Pumphead Enclosure Material: _____

Rotor Material: _____

Vent Body Material: _____

Vent Springs Material: _____

` Other Materials: Compatible with liquid handled and manufacturer's standard for intended service.__

Tag Numbers: _____

Graduated Calibration Chamber (Y/N) _____Y, one for each of two skids_____

Useable Volume: 200 mL _____
Diameter: _Determined by manufacturer__

TESTING

Pump Tests: Field Functional (Y/N) __ Field Performance (Y/N) _____

Motor Test: Short Commercial (Y/N) __N____ Other _____

REMARKS _____

_____

_____

SECTION 11303
SUBMERSIBLE SOLIDS-HANDLING PUMPS

PART 1 - GENERAL

1.01 SCOPE

A. The contractor shall furnish and install submersible solids-handling pumps and associated equipment equal to the performance tabulated in schedule at the end of this section. The installation shall be complete with all needed equipment, control system, and lifting equipment for the lift station.

B. At the lift station, the principal items of equipment shall include two vertical, close-coupled, motor driven, non-clog pumps; local three-phase power and control panel with circuit breakers: motor circuit protectors; motor starters; pressure transducer level sensor; 120v and 24v control power transformers; and all internal wiring. System shall also include duplex, freeze-protected liquid fill discharge pressure gauges. System shall also include guide rail systems for removal or re-installation of pumps.

C. Design and provide anchorage to concrete, including embedment depth. The following shall be submitted by the Contractor:

1. Detailed drawing with anchorage and embedment dimensions.

2. A table of applied forces.

3. A complete bill of materials.

4. Stamp of a Registered Professional Engineer, registered in the State of Georgia, experienced in pump support and anchorage design.

5. Detailed connections to the existing structure.

6. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1-1.7.

D. Submittals. In addition to requirements listed in 01300 Submittal Procedures, provide the following:

1. Factory pump curve data

2. Storage Requirements

3. Transportation

4. Quality Assurance certification

5. Testing procedures

6. Operations and Maintenance manuals

7. Operations Staff Training Syllabus Example

8. List of spare parts

PART 2 – PRODUCTS

2.01 PUMPS

A. The submersible pumps shall be vertical, centrifugal non-clog type of heavy cast-iron construction, especially designed for the use of mechanical seals and self-priming. The shaft bearing nearest the pump impeller shall be locked in place so that end play is limited to the clearance within the bearing. The motor shaft shall be directly connected to the impeller without the use of drive belts or couplings. The shaft shall be solid stainless steel through the mechanical seal. The pump impeller shall be of the enclosed two-port type made of close-grained cast-iron and shall be balanced.

B. Pump Casing: The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. The volute shall have smooth passages which provide unobstructed flow through the pump.

C. Mechanical seals:

1. Pump shall be provided with tandem double opposed heavy-duty mechanical seals running in an oil reservoir, composed of two separate lapped face seals. The lower seal unit, between the pump and oil chamber, shall consist of one stationary and one positively driven, rotating silicon-carbide ring and one positively driven silicon-carbide or rotating carbon ring. Ceramic seals will not be acceptable.

2. The seals shall require neither maintenance nor adjustment and shall be easily replaceable. Conventional double mechanical seals with a single or a double spring between the rotating faces, or that require constant differential pressure to effect sealing and are subject to opening and penetration by pumping forces, will not be acceptable. The submersible pumps shall be capable of continuous submergence without loss of watertight integrity to a depth of 65 feet.

3. Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed to assure that air is left in the oil chamber, to absorb the expansion of the oil due to temperature

variations. The drain and inspection plug with positive anti-leak seal shall be easily accessible from the outside.

4. A moisture detection sensor shall be provided in the motor housing to detect seal failure.

D. Cable and Cable Entry Seal: The cable entry water seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top. The power cable shall be of sufficient length to reach pump control panel without splicing. It shall be the Contractor's responsibility to coordinate the cable length.

E. Impeller: The impeller shall be of the cast iron single shrouded non-clogging design to minimize clogging of solids, fibrous materials, heavy sludge, or other materials found in industrial wastewater. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to the first critical speed at 150 percent of the maximum operating speed. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

F. Wearing Rings: Wearing rings, when required, shall be renewable type and shall be provided on the impeller and casing and shall have wearing surfaces normal to the axis of rotation. Material for wear rings shall be stainless steel. Wearing rings shall be designed for ease of maintenance and shall be adequately secured to prevent rotation.

G. Discharge Connection Elbow: Each pump shall be provided with a cast iron discharge connection elbow with flanged outlet to the discharge pipe, integrated lower guide bar support and slip face metal to metal discharge connection to the pump.

H. Rail Mounted Systems: Rail mounted installation systems shall consist of guide rails, a sliding bracket, and a discharge connection elbow. Guide rails shall be of the size and type standard with the manufacturer and shall not support any portion of the weight of the pump. The sliding guide bracket shall be an integral part of the pump unit. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump shall be automatically connected to the discharge connection elbow

when lowered into place and shall be easily removed for inspection and service without entering the pump well.

I. Lifting Chain: Lifting chain to raise and lower the pump through the limits indicated shall be provided. The chain shall be galvanized and shall be capable of supporting the pump.

2.02 MOTORS

A. The pump motor power shall be 460V, 60Hz, three-phase for each pump station.

B. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air-filled or oil-filled, watertight chamber. Motor shall have a service factor of 1.2 or greater. Motors shall be sized to operate below their full load amps; operating in the service factor is not acceptable.

C. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation which shall be rated at a temperature of 155 degrees C. The motor shall be designed for continuous duty, capable of sustaining a maximum of 10 starts per hour.

D. The junction chamber, containing the terminal board, shall be hermetically sealed from the motor. Connection between the cable conductors and stator leads shall be made with threaded compressed-type binding post permanently affixed to a terminal board. The submersible electrical cable shall be of sufficient length to reach the junction box.

E. Pump motors shall be equipped with motor winding thermal (one for each phase) and seal failure protection sensors. The sensors' cables shall be prewired to the motor for connection to the associated protection relays mounted in pump control panel.

F. The motor shall be suitable for Class 1, Division 1 environments.

2.03 CONTROLS

A. One (1) control panel shall be supplied by pump manufacturer to power, control and monitor the pumps at each station. The pump control panel shall contain all of the necessary components for system operation including, but not limited to the following:

1. Main circuit breaker, sized per manufacturer, with a lockable handle for lock out purposes on the exterior of the panel. The switch shall be

operable without opening the panel, shall be interlocked with the panel door and shall be capable of being padlocked in the "Off" position.

2. 2 kVA, 460/120V control power transformer with primary and secondary fuses
3. Motor Circuit Protectors (MCP) and NEMA rated RVSS starters sized for each pump motor HP
4. Surge Protective Device (SPD) for incoming 460V power
5. Elapsed time meters for each pump
6. UPS sized for 30min backup time
7. Panel interior lighting fixture with door switch.
8. Flygt Multi-Smart or equal controller to accommodate all listed I/Os Include 20% spare I/Os of each type.
9. 24VDC Power Supply
10. Level Indicator for submersible pressure transducer signal
11. Thermal and seal failure relays for each pump
12. 120V surge protector
13. Pumps alternator
14. Time delay relay (0-10 sec) for between pumps start in both "Hand" and "Auto" modes
15. Surge protectors for all analog signals to/from the panel.
16. Alarm Light and Reset pushbuttons
17. Panel interior 120VAC duplex receptacle
18. Panel space heater, fan and thermostat
19. The following devices shall be mounted on the panel front:
    a. Hand-Off-Auto selector switches for each pump

b. Start and Stop pushbuttons for each pump in Hand mode only.

c. Indicating lights for each pump Running, Stopped, Overtemperature, Seal Leakage and Overload conditions

d. Indicating light for wetwell high level from high level float switch

e. Alarm Reset pushbuttons.

f. Mushroom-head E-Stop pushbutton.

20. All other components (fuses, circuit breakers, relays, etc.) for pumps safe and proper operation.

21. Pilot device colors:

a. Run: Red

b. Off: Green

c. Warning: Amber

B. Control panels shall have NEMA 4X stainless steel enclosures.

1. White epoxy painted stainless steel panel

2. 3-point handle latch

3. Sun shield: aluminum, epoxy painted white

4. UL certified and labeled

C. All control wiring shall be 24 VDC.

D. All wire tags inside the panels shall be legible and shall not deteriorate under adverse conditions.

E. The following auxiliary dry contacts (120VAC, 5 Amp rated) and signals shall be provided:

1. PUMP 1 RUNNING

2. PUMP 2 RUNNING

3. PUMP 1 COMMON FAULT

4. PUMP 2 COMMON FAULT

5. WETWELL HIGH HIGH LEVEL ALARM

6. WETWELL HIGH LEVEL ALARM

7. WETWELL LOW LEVEL ALARM

8. WETWELL LEVEL (PRESSURE)

F. Electrode/Conductance Relay Level Switch per **Section 17563 – Pressure and Level Instruments**.

G. Floats to be configured per Drawings. Float switches shall be suitable for Class 1, Division 1 environment. Float switches shall be provided with a sufficient amount of cable to reach the pump control panel without splicing.

H. Thermal sensor relay and alarm light, push to test, with latching relay to hold light in “on” position upon high temperature trip while allowing the circuit to reset upon cool down automatically.

I. Seal Failure relay and warning light, push to test and warning only.

J. Flashing Alarm Light, with reset pushbutton for high level. The alarm light shall be a weatherproof-shatterproof red/green/amber light fixtures mounted on top of canopy to indicate operating, warning, and alarm conditions. The alarm light shall be turned on by the alarm level. The alarm light shall flash until the alarm condition ceases to exist. Circuit should reset upon alarm condition clearing.

K. See Electrical Drawings for additional details.

2.04 MAIN PIPING

A. The pump suction connections shall be drilled and tapped for a 125-pound ANSI flange. See **Section 15100 - Valves and Appurtenances** for reference.

2.05 MANUFACTURERS

A. Flygt

B. Sulzer

C. Preapproved equal

PART 3 - EXECUTION

3.01 STARTUP

A. The manufacturer shall provide the services of a factory-trained representative for a period of one 8-hour day on-site to perform initial startup of EACH pump station and to instruct the owner's operating personnel in the operation and maintenance of the equipment.

3.02 SUBMERSIBLE SOLIDS-HANDLING PUMP SCHEDULE

Wani Road Lift Station Design Criteria

Asset	Criteria	Units		
Pumps	Type	--	Cast iron, non-clog, submersible	
	Number	--	2	
	Operating Condition		Initial @0.2 MGD	
	Station Firm Capacity	gpm	420	
	Capacity per Pump	gpm	420	
	Force Main Velocity	fps	3.5	
	Total Dynamic Head	ft	150	
	Maximum Static Head	ft	135	
Wet Well	Material		Precast concrete	
	Diameter	ft	10	
			Start-up @0.03 MGD	Initial @0.2 MGD
	Volume per vertical ft	gal	290[1]	580
	Note 1 - Wet well diameter will be 10 feet with a removable bulkhead dividing the wet well in half. Estimated startup flow of 0.03 mgd ADF will use half the wet well and the unused half will allows for some equalization storage via high level spill over. The bulkhead will be removed as flows increase and cycle times exceed ~15 starts per hour.			
	PS Top of Slab	ft-msl	658	
	High Level Alarm	ft-msl	625	
	Lag Pump On	ft-msl	624	
	Pump Off	ft-msl	621	
	PS Floor Elevation,	ft-msl	617	
	Operating Condition		Start-up @0.03 MGD	Initial @0.2 MGD
	Cycle Time	min	10	10
	Cycles per Hour	--	6	6

Electrical And I&C	Motor Horsepower	hp	35
	Motor Speed	rpm	3550
	Motor Voltage	--	460 Volt, 3 Phase
	Type of Drive	--	Constant Speed w/ soft start motors
	Pump Operation	--	Wet Well Level Control System using level probes (not floats)
Emergency Operation	Diesel or gas generator		Piping also equipped with camlock for portable bypass pump setup

3.03 FIELD TESTING AND ADJUSTING EQUIPMENT

A. Operational Test: Prior to acceptance, an operational test of all pumps, drivers, and control systems shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. **Contractor** shall furnish labor, piping, equipment, water, and materials necessary for conducting tests.

1. Prior to applying electrical power to any motor driven equipment, the drive train shall be rotated by hand to demonstrate free operation of all mechanical parts.

2. Tests shall demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms with the specified operating characteristics.

3. During tests, make observations of head, capacity, motor input, noise levels and vibration levels at pump.

4. Tests shall include checks for excessive vibration or overheating, leaks in all piping and seals, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power consumption.

B. Retesting: If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted.

C. Performance Test Report: Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. In each test report indicate the final position of controls.

3.04 MANUFACTURER'S SERVICES:

A. Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment. A minimum of 3 trips and 16 hours per lift station for a total of 48 hours on site time shall be provided by the pump manufacturer’s representative.

3.05 O&M MANUALS

Submit 2 copies of operation and maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown.

Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides.

Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

Manuals shall be approved prior to the field training course.

3.06 FIELD TRAINING:

A. Provide a field training course for designated operating and maintenance staff members. Training shall be provided for a total period of 4 hours of normal working time per lift station and shall start after the system is functionally complete but prior to final acceptance tests. A minimum of 3 trips, one per station and a total of 12 hours field training shall be provided. The 4 hour field training shall be divided into two 2 hour sessions to accommodate Owner’s day and night shift O&M personnel.

Field training shall cover all of the items contained in the operating and maintenance manuals.

END OF SECTION

SECTION 11350
NON-POTABLE & POTABLE
WATER BOOSTER PUMPS

PART 1 - GENERAL

1.01 SCOPE

A. The contractor shall furnish and install tow booster pump packages:

1) a simplex non-potable water booster pump package and,

2) a duplex potable water booster pump package.

The packages shall include variable speed pumps installed as a prefabricated system designed to deliver the scheduled flow and pressure differential as indicated in the drawings. Each package shall be skid mounted and shall require a single power connection to the system panel and a single suction and a single discharge piping connection. All other wiring and piping internal to the prefabricated system will be provided by the pump package manufacturer. Each package shall be complete with all needed equipment, piping, valves control panel and mounted on a skid.

B. The principal items of equipment for each package shall include one or two horizontal or vertical, close-coupled, motor driven, water booster pumps; local single-phase power and control panel with circuit breakers: motor circuit protectors; motor starters; pressure transducer level sensor; 120v or 240v and 24v control power transformers; and all internal wiring.

C. Each skid shall also include an enclosure with an internal heater to protect against freezing.

D. Design and provide anchorage to a concrete pad, including embedment depth.

E. Submittals. In addition to requirements listed in **Section - 01300 Submittals**, provide the following:

1. Factory pump curve data
2. Storage Requirements
3. Transportation
4. Quality Assurance certification
5. Testing procedures
6. Operations and Maintenance manuals
7. Operations Staff Training Syllabus Example
8. List of spare parts

PART 2 – PRODUCTS

2.01 PUMPS

A. The submersible pumps shall be horizontal or vertical, centrifugal water pumps, close coupled with 316L stainless steel casing and internals. The shaft bearing nearest the pump impeller shall be locked in place so that end play is limited to the clearance within the bearing. The motor shaft shall be directly connected to the impeller without the use of drive belts or couplings. The shaft shall be solid stainless steel through the mechanical seal. Pump assemblies shall be ANSI/NSF-61 certified.

B. Pump Casing: The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. The volute shall have smooth passages which provide unobstructed flow through the pump.

C. Mechanical seals:

1. Pump shall be provided with tandem double opposed heavy-duty mechanical seals running in an oil reservoir, composed of two separate lapped face seals. The lower seal unit, between the pump and oil chamber, shall consist of one stationary and one positively driven, rotating silicon-carbide ring and one positively driven silicon-carbide or rotating carbon ring. Ceramic seals will not be acceptable.

2. The seals shall require neither maintenance nor adjustment and shall be easily replaceable. Conventional double mechanical seals with a single or a double spring between the rotating faces, or that require constant differential pressure to effect sealing and are subject to opening and penetration by pumping forces, will not be acceptable. The submersible pumps shall be capable of continuous submergence without loss of watertight integrity to a depth of 65 feet.

3. Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed to assure that air is left in the oil chamber, to absorb the expansion of the oil due to temperature variations. The drain and inspection plug with positive anti-leak seal shall be easily accessible from the outside.

4. A moisture detection sensor shall be provided in the motor housing to detect seal failure.

D. Impeller: The impeller shall be of stainless steel, single, open design. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to the first critical speed at 150 percent of the maximum operating speed. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

E. Wearing Rings: Wearing rings, when required, shall be renewable type and shall be provided on the impeller and casing and shall have wearing surfaces normal to the axis of rotation. Material for wear rings shall be bronze or stainless steel. Wearing rings shall be designed for ease of maintenance and shall be adequately secured to prevent rotation.

2.02 MOTORS

A. Pump motors shall be TEFC from 1 HP to 10 HP. Package skids shall be factory assembled including pumps, motors and controls. The systems shall be factory wired and tested.

2.03 CONTROLS

A. Each skid shall include one (1) NEMA 1 control panel to power, control and monitor the pumps. The pump(s) will stop during periods of low demand and restart upon a drop in system pressure. The pump control panel shall contain all the necessary components for system operation including, but not limited to the following:

1. Main circuit breaker, sized per manufacturer, with a lockable handle for lock out purposes on the exterior of the panel. The switch shall be operable without opening the panel, shall be interlocked with the panel door and shall be capable of being padlocked in the "Off" position.

2. 2 kVA, 460/120V control power transformer with primary and secondary fuses

3. Motor Circuit Protectors (MCP) and NEMA rated RVSS starters sized for each pump motor HP

4. Surge Protective Device (SPD) for incoming 460V power

5. Elapsed time meters for each pump

6. 120V surge protector

7. Duplex models provide automatic alternation to achieve even pump usage, and units can be sized to act as 100% stand by or stage pumps based on demand. Lag pump will start automatically upon failure of lead pump and pump failure is indicated at the panel.

8. Time delay relay (0-10 sec) for between pumps start in both "Hand" and "Auto" modes

9. Surge protectors for all analog signals to/from the panel.

10. Low suction pressure cutout.

11. Pump runout protection.

12. Dry running protection.

13. Alarm Light and Reset pushbuttons

14. The following devices shall be mounted on the panel front:

    a. Hand-Off-Auto selector switches for each pump

    b. Start and Stop pushbuttons for each pump in Hand mode only.

    c. Indicating lights for each pump Running, Stopped, Overtemperature, Seal Leakage and Overload conditions

    d. Alarm Reset pushbuttons.

    e. Mushroom-head E-Stop pushbutton.

15. All other components (fuses, circuit breakers, relays, etc.) for pumps safe and proper operation.

16. Pilot device colors:

    a. Run: Red

    b. Off: Green

    c. Warning: Amber

B. All control wiring shall be 24 VDC.

C. All wire tags inside the panels shall be legible and shall not deteriorate under adverse conditions.

D. The following auxiliary dry contacts (120VAC, 5 Amp rated) and signals shall be provided:

1. PUMP 1 RUNNING
2. PUMP 2 RUNNING
3. PUMP 1 COMMON FAULT
4. PUMP 2 COMMON FAULT
5. LOW SUCTION PRESSURE

E. See Electrical Drawings for additional details.

2.04 MAIN PIPING

A. The pump suction connections shall be drilled and tapped for threaded connections. See **Section 15100 – Valves and Appurtenances** for reference.

2.05 MANUFACTURERS

A. Xylem/ Goulds AquaBoost

B. Grundfos

C. Preapproved equal

PART 3 - EXECUTION

3.01 STARTUP

A. The manufacturer shall provide the services of a factory-trained representative for a period of one 8-hour day on-site to perform initial startup of EACH pump package and to instruct the owner's operating personnel in the operation and maintenance of the equipment.

3.02 PUMP SCHEDULE

A. Refer to the Process Mechanical Drawings for the pump design criteria.

3.03 FIELD TESTING AND ADJUSTING EQUIPMENT

A. Operational Test: Prior to acceptance, an operational test of all pumps, drivers, and control systems shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. **Contractor** shall furnish labor, piping, equipment, water, and materials necessary for conducting tests.

1. Prior to applying electrical power to any motor driven equipment, the drive train shall be rotated by hand to demonstrate free operation of all mechanical parts.

2. Tests shall demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms with the specified operating characteristics.

3. During tests, make observations of head, capacity, motor input, noise levels and vibration levels at pump.

4. Tests shall include checks for excessive vibration or overheating, leaks in all piping and seals, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power consumption.

B. Retesting: If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted.

C. Performance Test Report: Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. In each test report indicate the final position of controls.

3.04 MANUFACTURER'S SERVICES:

A. Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment. A minimum of 2 trips and 4 hours per package system for a total of 16 hours on site time shall be provided by the pump package manufacturer’s representative.

3.05 O&M MANUALS

Submit 2 copies of operation and maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown.

Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides.

Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

Manuals shall be approved prior to the field training course.

3.06 FIELD TRAINING:

A. Provide a field training course for designated operating and maintenance staff members. Training shall be provided for a total period of 2 hours of normal working time per booster pump package and shall start after the system is functionally complete but prior to final acceptance tests. A minimum of 2 trips, one per package and a total of 8 hours field training shall be provided.

   Field training shall cover all of the items contained in the operating and maintenance manuals.

END OF SECTION

SECTION 11500
WRF PERFORMANCE REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes installation, startup, and performance of the **Owner**-procured Water Reclamation Facility (W RF).

B. The WRF is to be a complete-mix activated sludge facility with bolt-up construction consisting of rectangular tanks for aeration and aerobic digestion; circular clarifiers; blowers and associated control system; and a chlorine contact tank and dechlorination chamber for effluent disinfection.

C. Roles and Definitions:
   1. **Owner** (SCWA): **Owner** and ultimate operator of the WRF.
   2. **Manufacturer** (Southwest Fluid Products): supplier of WRF equipment and responsible for a design that meets the requirements of the Design Development Report (DDR) and plans and technical specifications.
   3. **Contractor** (Lakeshore): purchaser, installer of all WRF process units, equipment and ancillary equipment and responsible for the adherence to plans and technical specifications, adherence to manufacturers' installation requirements and responsible for overall WRF performance requirements. .
   4. **Engineer** (R2T, Inc): Responsible party in charge of the design of the WRF in accordance with GA EPD Memo dated July 26, 2012, titled "Certification Process for Plans and Specifications Submittals."

C. Submittals:
   1. Operations and Maintenance Manuals:

      a. Maintenance and operating instructions including routine adjustments and lubrication for all wastewater treatment plant equipment provided. Special emphasis shall be placed on preventive maintenance and safety recommendations.

      b. Shop drawings as approved by the **Contractor**. These will be filed as "Record Copies".

      c. Copies of all submittal data sheets as approved by the **Contractor**. These will be filed as "Record Copies".

      d. All maintenance and operating instructions provided by the

manufacturers of purchased equipment, i.e. clarifier drive mechanism, blowers, motors, and all electrical equipment.

e. All testing data as described in Part 3 below.

D. WRF Unit Process Performance Requirements:
The **Manufacturer** shall be responsible for meeting performance requirements and testing for the following unit processes and equipment, herein referred to as the "System":

1. Influent Screening Structure (hydraulic test only)
2. All Aeration Basins including the Swing Basin
3. Aerobic Digester
4. Secondary Clarifiers
5. Chlorine Contact Tank (hydraulic test only)
6. Aeration Diffusers and Blowers
7. Internal Air Lift Recycle Pumps

The Manufacturer is not responsible for the installation or performance of the following unit processes, equipment or testing requirements:

1. Influent Screening Equipment
2. Chemical Feed Systems
3. Solids Dewatering
4. Filling of tanks for testing / biological seeding
5. Disinfection Treatment
6. Cost of performance testing analytical work.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 FIELD SERVICES SUMMARY

The basic equipment and services furnished by the **Manufacturer** shall be defined by the **Contractor** and as a minimum shall include tanks, walkways, platforms, grating, equipment, aeration diffusers and piping, blower assemblies, clarifier drives and related equipment, internal piping, weirs, gates, baffles, valves, air lift pumps, electrical controls for blower assemblies, effluent flowmeter, and all necessary plant mounted electrical equipment and/or controls.

3.02 PROCESS PERFORMANCE GUARANTEE

A. Effluent Warranty

The **Manufacturer** guarantees to the **Owner** that the System will produce

an effluent stream that meets the specified Effluent Wastewater Characteristics (as outlined in **Table B**), herein referred to as the “Effluent Warranty”, provided that the System is:

(i) installed, started up, and operated and maintained according to the **Manufacturer’s** drawings, manuals, and instructions,

(ii) supplied with an influent stream from the **Owner** that meets the Influent Wastewater Characteristics (as defined in **Table A)**,

(iii) (iii) equipped with all necessary utilities and permits provided by the **Owner** for normal operation, and

(iv) (iv) not subjected to limitations from other unit processes that could negatively affect the System's performance. This includes, but is not limited to, pretreatment equipment, and any side streams from other processes that are returned to the influent stream comprising the Influent Wastewater Characteristics.

Table A shows the average daily design flow, peak flow and startup flow. The influent wastewater characteristics are assumed to be the same for average and startup flow conditions and represent maximum month loading.

Table A: Influent Wastewater Characteristics (influent to the System)

Parameter	Value	Units
Startup/Test flow	.030	MGD

Average Daily Flow	.200	MGD
Peak Day Flow (24 hr sustained)	.600	MGD
$CBOD_5$	271≤	mg/L
TSS	348≤	mg/L
TKN[1]	65≤	mg/L
Ammonia Nitrogen	39≤	mg/L
Total Phosphorus	10≤	mg/L
Dissolved Oxygen	N/A≤	mg/L
Minimum pH[2]	N/A	S.U.
Maximum pH[2]	N/A	S.U.
Min Wastewater Temperature	15	Degrees C
Max Wastewater Temperature	25	Degrees C
Influent CBOD/TKN Ratio not less than 3.5:1		
[1] The concentration of refractory, non-biodegradable Organic Nitrogen does not exceed 1.5 mg/L.		
[2] Sufficient alkalinity and nutrients are either present or supplied by others to maintain proper biological conditions throughout the process.		
Inhibitory Matter and Heavy Metals Concentrations not to exceed threshold limits as defined in, but not limited to, Appendix I.		
N/A = Not Applicable		

Table B: Secondary Clarifier Effluent
Wastewater Characteristics (effluent from System)

Parameter	Value	Units
CBOD	15≤	mg/L
TSS	20≤	mg/L
Ammonia Nitrogen	5≤	mg/L
Total Nitrogen	N/A≥	mg/L
Nitrate Nitrogen	N/A≤	mg/L
Total Phosphorus	5≥	mg/L
N/A = Not Applicable		

3.03 WARRANTY

All warranties expressly provided to **Owner** of this Warranty Document are collectively referred to as (the “Warranty”).

3.04 ACCEPTANCE TESTING

A. Timing of Test

1. The **Owner** shall inform the **Manufacturer** in writing when the System is ready for start-up. After start-up is completed, the **Owner** will provide written notice to the **Manufacturer** at least thirty (30) days in advance of the System being ready for testing (the "Acceptance Test"). The Performance Test will commence no sooner than thirty (30) days after start-up and must be completed within either eighteen (18) months from the date of delivery of the System or eight (8) months from the completion of start-up, whichever comes first. The Performance Test will continue until one of the following conditions is met:

    a. A consecutive 12-day testing period demonstrates that both influent characteristics and effluent values comply with **Tables A** and **B** in Section 3, or

    b. If the **Owner** corrects any influent deficiencies as permitted under Section 3.04(C), a consecutive 12-day testing period shows that the effluent values (**Table 2**) meet the Guarantee, regardless of the influent characteristics (**Table 1**).

This timeframe will be referred to as the "Performance Test Period." The period may be extended by mutual agreement between the **Owner** and **Manufacturer** if unforeseen conditions arise. During the Performance Test Period, the **Owner** will collect daily 24-hour composite samples of both influent and effluent. The **Owner** is responsible for drawing the samples, supplying the necessary equipment, and covering all analytical testing costs at an independent laboratory. The **Manufacturer** will provide a representative on site during the Performance Test Period to operate the plant.

Once the performance criteria outlined in either paragraph "a" or "b" are met, the **Manufacturer's** obligations under the Warranty Document will be considered fully satisfied.

B. Testing Protocol

The **Manufacturer** shall direct the operations of the System according to the **Manufacturer**'s written operating instructions, using a qualified Operations Representative (herein **Ops Rep**) with proven experience in operating similar mechanical equipment. The **Owner** shall provide an Operator, certified or licensed by the State where the System is located, to be onsite during the test period. The Operator shall take direction from the **Ops Rep** during the testing regarding the operations, sampling and testing of the plant. The Operator shall not make adjustments or changes to the plant operations without direction from the **Ops Rep**.

Before testing begins, the **Owner** must submit all sampling and laboratory analysis methods for the **Manufacturer**'s approval. This includes the intended

test protocol, certification of the laboratory conducting the analyses, sample locations, parameters to be analyzed, sampling frequency, and methods of analysis for each parameter. All analyses, data reduction, or tests not specifically detailed must follow procedures approved by the **Manufacturer**. The primary reference will be the most recent edition of "WEF Standard Methods for Examination of Water and Wastewater," unless an alternative source is agreed upon by both the **Owner** and the **Manufacturer**.

The test data, along with documentation showing adherence to the **Manufacturer**'s recommended operating and maintenance procedures, must be provided to the **Owner** immediately upon request.

C. Nonconforming Conditions

Consequences of Influent and/or Effluent Not Conforming to Specifications.

1. Non-Conforming Influent: If after 12 consecutive days of testing, the average Influent Wastewater Characteristics (**Table A**) do not meet the specified limits and the average effluent from the System exceeds the Effluent Wastewater Characteristics (**Table B**), the **Owner** must take corrective actions until the Influent Wastewater Characteristics comply with the specified requirements for at least two (2) weeks. Additionally, the System's effluent must stabilize at steady-state conditions, indicated by no downward trend in the measured concentrations of parameters in **Table B** (based on five (5) days of 24-hour composite samples). After these conditions are met, the **Manufacturer** shall restart the Testing Program. The **Owner** is allowed a total of three (3) attempts to take corrective actions. If the influent continues to be out of compliance after these attempts, the **Manufacturer**'s obligations under the Warranty will be considered fully satisfied.

2. Non-Conforming Effluent: If after 14 days of testing, the average influent to the System meets the specified Influent Wastewater Characteristics, but the average effluent does not meet the Effluent Wastewater Characteristics after achieving steady-state conditions, the **Manufacturer** must notify the **Owner** in writing. Upon receiving this notice, the **Manufacturer** will provide a written performance evaluation of the System and may recommend operational changes to achieve compliance. The **Manufacturer** must implement these operational changes within a reasonable timeframe. If additional equipment installation or modifications are required, the **Manufacturer** will carry out these changes within a reasonable period. Provided the influent continuously meets the Influent Wastewater Characteristics, the **Manufacturer** shall restart the Testing Program once the System's effluent reaches steady-state conditions. If steady-state

conditions are not achieved within 30 days of the operational or equipment changes, the **Manufacturer** will reassess the System's performance and may suggest further operational changes, with a total of three (3) recommendations allowed. If the effluent values continue to exceed those specified in **Table B** after implementing these changes, the **Manufacturer** may install additional equipment and/or modify the System at its discretion, at its cost, and within a reasonable timeframe. Once the effluent stabilizes at steady-state conditions, the **Manufacturer** may restart the Testing Program. If necessary, up to two (2) additional retests may be conducted after equipment modifications. The nature of these modifications will be determined solely by the **Manufacturer**, who will complete them within a reasonable period and at its cost, per the Appendix terms at end of this Section.

During the Performance Test Period, the **Owner**'s personnel and the **Owner**'s **Contractor** may visit the site to assess System performance and investigate reports of non-conformance. The necessity, frequency, and duration of these visits will be at the **Owner's** discretion.

D. Test Results Submittal

The consecutive 12-day test shall be performed as described in Part 3.04.A. In addition to influent and effluent sampling the **Manufacturer** shall also collect daily samples and record Aeration Basin MLSS, D.O., RAS and WAS Flow, and sludge blanket depth in the Clarifier.

Following successful completion of the test, a desktop State Point Analysis (SPA) shall be performed using the Overall Process Test data documenting the secondary clarifier performance. The SPA shall show the expected operating points at Startup, Average Day, Max Month and Peak Day flow conditions. The SPA shall follow the mathematical methods published in WEF and other periodicals and based on work by Dr. Eric Wahlberg. The State Point Analyses shall show predicted secondary clarifier performance based on predicted operating data consisting of the following six data inputs: 1) Influent flow rate, 2) Return activated sludge (RAS) flow rate, 3) Mixed liquor suspended solids (MLSS) concentration, 4) Clarifier surface area, 5) Number of clarifiers in service and 6) Sludge volume index (SVI). The SPA shall demonstrate stable operation under all four flow conditions.

In addition to the SPA, a summary of operating data shall be prepared showing the design criteria compared to the process test average flow rate and actual performance test data. The criteria and data shall summarize both the aeration basin and secondary clarifier operation.

The State Point Analysis and test period date shall be submitted to the **Contractor** and **Engineer** for review and acceptance.

3.05 HYDRAULIC TESTING

1. **Peak Flow Test**. Prior to performance testing and prior to receiving influent wastewater, the Swing Basin, one Aeration Basin and one Clarifier shall be isolated from the plant influent and filled with water. **Engineer** to select flow path. Using a pump and flow meter provided by the **Manufacturer**, the pump shall be run at the Peak Hour Flow of 0.6 mgd, equal to 417 gpm, for at least 1 hour and successfully demonstrate that the basins and piping can convey the flow without overtopping the basins. The Wani Road Lift Station has a peak capacity of 417 gpm with both pumps running and can be used to pump flow through the basins. Water for the test can be obtained either by tanker truck or by pumping water from Cabin Creek in to the lift station wet well. If Cabin Creek water is used, a suction screen should be used to prevent damage to the pump impellers.

2. **Leak Test**. An additional task for hydraulic testing is a leak test. All basins shall be filled with water. Representatives from both the **Owner** and **Manufacturer** shall inspect the tanks and interconnecting piping between basins. If defects or leaks are encountered, **Manufacturer** will repair them and reschedule another walk-though to confirm repair. **Manufacturer** to prepare statement of leak-free operation and hydraulic capacity as part of final submittal data.

3.07 DIFFUSER FACTORY TEST DATA

Manufacturer's factory test data for the coarse bubble diffusers shall be provided with the submittals demonstrating test results based on ANSI/ASCE 2-91, Standard for Measurement of Oxygen Transfer in Clean Water. The test data can be from prior testing. New testing is not required unless the diffuser design has been modified since the last factory testing was completed.

The data shall include a summary or report stating the diffuser design basis and factory test results for Standard Oxygen Transfer Rate (SOTR), Standard Aeration Efficiency (SAE) and Oxygen Transfer Efficiency (OTE) demonstrating the number and spacing of the diffusers meets or exceeds the **Manufacturer's** design requirements under Maximum Month influent loading conditions.

Onsite testing of the diffusers is not required.

3.08 LIMITATION OF LIABILITY

Except for the **Manufacturer's** remedy obligations specifically outlined in the warranty document, and notwithstanding any failure of those remedies to fulfill their essential purpose, the **Manufacturer** is liable for actual delay damages including the actual costs of construction administration, engineering, & inspection. The manufacturer is not responsible for indirect or consequential damages. The manufacturer's total liability under this warranty document, in combination with all liability to the **Owner** and to the **Contractor**, the purchaser of the system under the system sale contract, shall not exceed the liability limitations stated in the system sale contract. These limitations apply regardless of whether the liabilities or damages are alleged to arise from contract, tort, strict liability, or any other legal theory.

(a) this warranty is the manufacturer's sole and exclusive warranty regarding the performance of the system. The manufacturer disclaims all other warranties, express or implied, including but not limited to any warranties of merchantability or fitness for a particular purpose.

(b) this warranty is subject to the terms and conditions of the system sale contract. The manufacturer's obligations under this warranty document depend on the **Owner** and **Contractor** not defaulting on any payment obligation to the **Manufacturer**.

Threshold Concentrations of Selected Pollutants Inhibitory to the Activated Sludge Process are as follows:

POLLUTANT	Concentration (mg/L)	
	Carbonaceous Removal[1]	Nitrification[2]
Aluminum	15 to 26	--
Ammonium	480	70.0
Arsenic	0.1	--
Borate (Boron)	0.05 to 100	--
Cadmium	10 to 100	14.3
Calcium	2500	--
Chromium (hexavalent)	1 to 10	0.25
Chromium (trivalent)	50	10
Copper	1.0	230
Cyanide	0.1 to 5	16.5
Iron	1000	--
Lead	0.1	0.5
Manganese	10	--
Mercury	0.1 to 5.0	--
Nickel	1.0 to 2.5	5.0

Silver	5	--
Sulfides	--	5.0
Zinc	0.08 to 10	11.0
Phenol	200	--
Phenolics (substituted)	--	0.2-100
Phenolic Acids	--	0.01
m-Cresol	--	1.0
o-Cresol	--	11.4
p-Cresol	--	12.8
2-4 Dinitrophenol	--	37

[1] From WPCF Manual of Practice No.8, 1977 Edition, Page 227

[2] From WEF Manual of Practice No. 29, 2005 Edition, Table 3.3, Pages 44-48

+++ END OF SECTION 11500 +++

SECTION 11550
MECHANICAL SCREEN AND SCREW CONVEYOR

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 all mechanical screen and screw conveyor units including support system(s), auger(s), bypass channel tank assembly, and motor controller(s). The equipment shall be installed as shown on the plans, as recommended by the supplier, and in compliance with all OSHA, local, state and federal codes and regulations.

B. The number of screening units shall be 4. Each system shall include the support system, auger, bypass tank, and motor controller.

C. 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.

D. The auger shall be capable of processing 0.8 MGD (refer to JWC flow curves).

1.02 SUBMITTALS

A. 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. Screen locations showing offset distances from surrounding facilities.
2. Screening unit design criteria including materials of construction, connection sizes, nameplate information, motor size and type, and flow curves.
2. Material spec sheets for screen mount, pipe, valves, controller, and other support equipment included in the screen package.
4. Operating and maintenance instructions and parts lists

1.03 REFERENCES

Support system(s), and auger(s) materials of construction shall, as applicable, meet the requirements of the following industry standards:

A. American Society for Testing and Materials (ASTM) A36: Standard Specification for Carbon Steel Plate

B. American Iron and Steel Institute (AISI) 304 Stainless Steel

C. American Iron and Steel Institute (AISI) 316 Stainless Steel

D. Motor controllers shall, as applicable, meet the requirements of the following Regulatory Agencies.

E. National Electrical Manufacturer's Association (NEMA) Standards

F. National Electrical Code (NEC)

G. Underwriters Laboratory (UL and cUL)

1.04 QUALITY ASSURANCE

Qualified suppliers shall have a minimum of five (5) years experience at manufacturing, support systems, inclined augers and motor controls with a minimum 400 installations of similar equipment. Supplier shall provide a list of names and dates of installations for verification by the Contractor. Supplier shall provide the services of a factory-trained representative to check the installation and to start-up the auger and controller. The factory representative shall have complete knowledge of proper installation, operation, and maintenance of equipment supplied. Representative shall inspect the final installation and supervise a start-up test of the equipment. Each auger and controller shall be factory tested to ensure satisfactory operation.

1.05 DELIVERY, STORAGE AND HANDLING

A. The equipment shall be packaged in containers constructed for normal shipping, handling and storage.

B. The containers shall provide adequate protection for the equipment in a dry indoor environment between +40°F (+4.5°C) and +100°F (+37.8°C) until time for installation.

1.06 IDENTIFICATION

Each unit of equipment shall be identified with a corrosion resistant nameplate,

securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, supplier's name, and location.

1.07 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 MANUFACTURERS

A. Support systems, auger and bypass tank assemblies, and motor controllers shall be in compliance with these specifications and plans and shall be supplied by one of the following manufacturers:

1. JWC Environmental®: Auger Monster® system Model No. AGE1800-285-1250-35

2. Approved equal

B. Manufacturers requesting to be selected as an approved equal shall submit certified documentation showing compliance with these specifications a minimum of ten (10) days prior to bid opening. Selected equipment manufacturers shall be added to the list of approved manufacturers.

C. The manufacturer must certify that the unit can be returned for maintenance to the factory or a local repair facility. The certification shall include a statement that there will be no charge for repair labor.

2.02 SUPPORT SYSTEM(S)

A. GENERAL

1. An auger system support frame with adjustable mounting brackets shall be provided for an 18 inch wide and a 32 inch deep channel.

2. An auger drive-end support shall be provided as required by the application. The drive end shall provide a method for pivoting the auger from the channel to perform simple maintenance. Installations with transport lengths of the auger greater than 4000 mm (157 in) shall require additional supports.

3. A horizontal support shall be provided for mounting an ultrasonic sensor upstream from the system support frame.

B. COMPONENTS

The support frame and additional supports shall be of welded square tube, angle, and plate construction. The construction material shall be 304 stainless steel unless noted.

2.03 AUGER(S)

A. GENERAL

1. The auger(s) shall be comprised of perforated screen segment, transport segment, discharge segment, and drive segment with a internal rotating spiral.

2. Each auger shall be installed at an inclination of 35 degrees from horizontal.

3. The auger screen segment trough with a rotating spiral shall provide particle capture and transport to the discharge segment outlet.

4. A wiper/brush shall be affixed to the outer edge of the spiral in the screen segment trough to provide trough cleaning and particle transport. The wastewater shall be permitted to pass through the screen segment and flow downstream.

5. Particles shall be washed both by the highly-agitated passing wastewater and by the discharge of a spray wash system. Dewatering shall occur as the rotating spiral conveys the washed screenings.

6. A spray wash assembly shall be provided to rinse the organic material from the processed solids back into the waste stream. The spray wash system shall consist of a set of nozzles providing an impact spray to hold solids against the screen trough for transportability. A spray wash solenoid valve shall be automatically energized by the system controller allowing wash water to spray into the screen segment whenever the auger spiral is in operation. The spray wash solenoid shall be automatically de-energized, stopping the flow of wash water whenever the auger spiral is stopped.

7. Starting of auger run cycles shall be initiated by signals from an ultrasonic level sensor.

B. COMPONENTS

1. Auger Spiral

    a. The 285 mm (11 ¼ in) spiral shall be made of high wear-resistant, alloy carbon steel.

b. The spiral shall have a grooved spiral designed into the outside diameter of the spiral for the mounting of the brush. The groove shall securely position the brush so that constant contact is maintained with the screen segment for the purpose of cleaning the perforations and the free passage of soft organics and liquids. Spirals that mount the brush to the face of the spiral shall not be acceptable.

c. The spiral shall have a welded drive plate for connection to the drive shaft.

d. The spiral tip speed shall not be more than 33 feet/minute (0.17 m/s).

e. The spiral transport speed shall not be more than 6.25 feet/minute (0.03 m/s).

2. Screen Segment

a. The screen segment trough shall be a replaceable, perforated stainless steel assembly. The perforated area of the segment shall be constructed of 14 ga. Sheet.

b. The screen trough perforations shall be 6mm for separation of the liquids from the solids

3. Transport Segment

a. The transport segment shall be a stainless steel assembly with inspection port(s). The segments shall be constructed of 10 ga. sheet.

b. The transport segment shall have stainless steel wear bars to support the rotating spiral.

4. Discharge Segment

a. The discharge segment shall be a stainless steel assembly with an inspection port and a full-width bottom discharge flange.

b. The discharge segment shall have a stainless steel endplate for mounting the drive segment.

5. Drive Segment

a. The drive segment shall be comprised of a drive shaft with welded drive plate, shaft seal, drive adapter spool, speed reducer and electric motor.

b. The shaft seal shall consist of a packing housing; four (4) PTFE impregnated packing cords, and adjustable packing ring.

c. The drive adapter spool shall be cast A536-84 ductile iron coated to inhibit corrosion.

d. The speed reducer shall have a reduction ratio of 160:1.

e. The electric motor shall be of 2 hp (1.5 kW), TEXP, 1,725 rpm, 460 volt, 3-phase, 60-Hz.

6. Spray Wash Assembly

a. The spray wash assembly shall consist of a one (1) 1 inch spray wash manifold, solenoid operated valve, manually operated ball-valve, and basket strainer.

b. The spray wash manifold shall be of stainless steel pipes and fittings. The spray nozzles shall consist of 40° “V” spray nozzles rated for 1.5 GPM @ 40 PSI and high 50° spray nozzles rated for 1.0 GPM @ 40 PSI.

c. The solenoid valve shall be of bronze construction, fitted with an explosion proof enclosure, housing a 120-volt, ac coil.

d. The manually operated ball valve shall be of 316 stainless steel and shall provide adjustment for the spray wash water flow.

6. Spray Wash Assembly (Cont’d)

e. A on (1) basket strainer shall be of SST material, with an 80 mesh 304 stainless steel screen and a plugged blow-off outlet.

f. A one (1) inch NPT double back-flow preventer (not supplied by equipment manufacturer) is recommended when using potable water for spray wash.

2.04 AUGER AND BYPASS CHANNEL TANK ASSEMBLY

A. Description

1. The tank shall house auger assembly and spray wash assemblies for the purpose of separating undesirable solids from the processed fluid. The tank shall include mounting tubes for the ultrasonic level sensors. Two spray wash assemblies shall direct water onto to the captured solids and perforations of the incline screw screen trough for purposes of cleaning.

2. The tank shall contain a 18” wide channel for the auger assembly and a 18” wide bypass channel with manual bar screen as shown on the drawings.

The bypass channel shall have a removable slide gate for the overflow weir as shown on the drawings.

B. Components

1. Tank

a. Tank shall have a class 150 6-inch inlet flange.

b. Tank shall have a class 150 6-inch discharge flange.

c. Tank shall be constructed of passivated 10 gauge AISI 304 stainless steel.

d. Tank shall include lifting points for slings and separate lifting points for forklift.

e. Tank shall include mounting points for spray wash assemblies.

2. Spray Wash Assemblies

a. Basket strainer shall be 304 stainless steel with 80 mesh screen.

b. Y-strainer shall be bronze construction with a 20 mesh AISI 304 stainless steel screen.

c. Solenoid valves shall be bronze body construction with a 120 volt AC Coil, explosion proof.

d. Ball valves shall be manual and constructed of 304 stainless steel.

e. Pipe and fitting shall be constructed of 316 stainless steel.

f. Spray nozzles shall be constructed of 303 stainless steel, V-spray.

g. Nozzles shall be AISI 303 stainless steel and rated 1.5 GPM @ 40 PSI.

2.05 PIVOT SUPPORT

A. Description

Pivot Support shall provide a structure for positioning and lifting of the inclined screw in or out of the tank. Pivot Support shall allow 360^0 rotation of the inclined screw once removed from the tank. Pivot Support shall include a

maintenance support stand for supporting of the inclined screw above the tank.

B. Components

1. Support and stand shall be constructed of AISI 304 stainless steel.

2. Support shall include braces for positioning of the Pivot Support relative to the tank.

3. Support stand shall allow inclined screw to disengage from stand without disassembly.

4. Pivot Support shall support inclined screw at a 35^0 inclination.

2.06 LEVEL SENSORS

A. GENERAL

1. The Auger Monster system shall be provided with upstream and downstream ultrasonic level sensors.

2. The level sensors will initiate auger run cycles based on channel head differential and the parameters set in the operator interface.

3. The PLC logic shall determine differential levels using signals from two (2) separately-mounted ultrasonic level sensors.

   a. One (1) level sensor shall be installed upstream of the system and measure the system's upstream water level.

   b. One (1) level sensor shall be installed downstream of the system and measure the channel's downstream water level.

   c. The head in front (upstream) of the system shall be compared to the head behind (downstream) of the system to determine the water level differential.

2.07 MOTOR CONTROLLER(S)

A. GENERAL

1. The controller shall provide independent control of the auger and spray wash assembly.

2. Controller shall be the supplier's standard UL/cUL listed Model PC-2231D.

3. The controller shall be rated for 2 hp (1.5 kW), 460 volts, 3-phase, 60-Hz.

B. OPERATION

1. The controller shall be equipped with an AUGER ON/OFF/RESET-LEVEL three (3) position selector switch.

    a. In the OFF/RESET mode the auger shall not run.

    b. In the ON mode the auger shall continuously initiate Auger Run Cycles.

    c. In the LEVEL position, auger run cycles shall be initiated by the ultrasonic level sensor or the Auger Start Timer.

    d. The auger shall only be reset by switching the AUGER ON/OFF/RESET-LEVEL switch to the OFF/RESET position.

2. The controller shall be equipped with a digital operator interface.

    a. The operator interface shall display auger run times, elapsed times, reversals, jams, motor overloads and over-temperature occurrences.

    b. The operator interface shall display Fail, Service Reminder, and Operational Messages.

    c. Operator interface function keys shall select the following displays: Date and Time, Auger Run Cycle, Auger Start Timer Interval, and System Monitor.

    d. The Auger Cycle Run times and Auger Start Timer shall be programmable. Settings shall be entered at the operator interface using panel keys to initiate a desired run sequence.

3. The controller shall be equipped with a programmable Level Sensor Backup Timer.

    a. The Level Sensor Backup Timer shall initiate an auger run cycle if the ultrasonic sensor fails to start an auger cycle within a preset interval of 0 to 999 minutes.

    b. The Level Sensor Backup Timer shall run the system continually when the timer is set to 0.

C. COMPONENTS

1. Enclosure

    a. Enclosures shall be NEMA 4X, 304 stainless steel construction and shall be suitable for wall mounting. Doors shall have corrosion-resistant

hinges and latches.

b. Enclosure shall house the control devices, relays, terminal blocks and reversing motor starters.

2. Control Devices

a. Operator interface and pilot devices shall be mounted on the enclosure front panel door.

b. The controller shall have indicator lights for AUGER RUN, and common FAIL.

c. The POWER ON, AUGER MOTOR OVERLOAD, AUGER MOTOR OVERTEMP, LEVEL SENSOR 1 FAILED, LEVEL SENSOR 2 FAILED and HIGH LEVEL ALARM shall be displayed by the operator interface.

d. Control devices shall be mounted in the front panel of the enclosure. Indicator lights shall be LED type pilot lights. Lights and the selector switches shall be heavy duty NEMA 4X type.

e. Control transformer shall be protected by two (2) primary fuses and one (1) secondary fuse. The 120-volt secondary shall have one (1) leg grounded.

f. Relay contacts shall be included for auger run, and common FAIL signal outputs. The contacts shall be rated 10 ampere, 240 VAC, resistive load.

3. Motor Starter

a. The motor tarter shall be a full-voltage reversing type with 120-volt operating coils.

b. Forward and reverse contactors on the starter shall have both mechanical and electrical interlocks.

c. Overload relays (OL) shall be adjustable so that the range selected includes the full load amperes (FLA) rating and service factor.

D. SAFETY FEATURES

1. When an auger jam condition occurs in the auger ON or LEVEL position the controller shall stop the auger, reverse the auger rotation to clear the obstruction. If the jam is cleared, the controller shall return the auger to normal operation. One (1) additional auger reversal (2 times total) may

occur within 30 seconds before the controller de-energizes the auger motor and activates the auger fail indicator and common fail relay.

2. If a power failure occurs while the auger is running, operation will resume running when power is restored.

3. If a power failure occurs while the auger is in a fail condition the fail indicator shall be reactivated when power is restored.

4. The controller shall provide overload protection for the motor through an overload relay mounted directly on the auger starter.

5. The controller shall be equipped with a main power disconnect switch. Motor branch circuits shall be short circuit protected.

3. Controller reset shall be from the local panel controls only.

PART 3 - EXECUTION

3.01 PREPARATION

A. Materials should be inspected for defects prior to installation and critical connections should be coordinated and confirmed to be correctly provided and placed prior to installation.

B. Avoid interferences with other trades.

3.02 INSTALLATION

A. General:

1. Furnish and install all materials and equipment necessary to complete the work.

2. Install equipment to at locations indicated on Drawings.

3. Make piping connections to equipment preventing excessive strain on equipment; install flexible connections where required.

B. Piping, Valves and Appurtenances:

1. Install in accordance with the requirements of Sections **15060 – Piping and Appurtenances** and **15400 - Plumbing**.

END OF SECTION

SECTION 11600

ROTARY PRESS PACKAGE

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 rotary press package complete with rotary press, shaftless screw conveyor, sludge pump, air compressor and pressure tank, and all control components and associated appurtenances required to provide a complete and operable package capable of conditioning and dewatering sludge and conveying dewatered solids to a container for disposal. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as indicated on the Drawings.

B. The Contractor shall provide all services, labor, materials, and equipment required for all site restoration and related operations necessary or convenient to the Contractor for furnishing a complete Work as shown on the Plans or specified in these Specifications.

C. 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.

D. Related Work Specified Elsewhere:

1. Section 15050, Basic Mechanical Materials and Methods
2. Section 15060, Piping and Appurtenances
3. Section 15400 - Plumbing
4. Section 16050, Basic Electrical Materials and Methods

1.02 SUBMITTALS

A. 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. Certified shop and erection drawings showing all important details of construction, sludge feed, wash water, high pressure air, and drainage connections, wiring diagrams, itemized motor horsepower, dimensions and anchor bolts.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. Data on the characteristics, features, and performance of the equipment.
4. The total weight of the equipment including the weight of the single largest item.
5. A complete total bill of materials for all equipment.
6. List of recommended spare parts
7. List of spare parts supply with contract

B. Operating and maintenance instructions and parts lists

1.03 QUALITY ASSURANCE

A. 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 Gear Manufacturers Association (AGMA)
2. American Welding Society
3. Conveyor Equipment Manufacturers Association (CEMA)
4. National Electrical Manufacturers Association (NEMA)
5. Anti-Friction Bearing Manufacturers Association (AFBMA)
6. American National Standards Institute (ANSI)
7. National Fire Protection Association (NFPA)
8. American Society for Testing Materials (ASTM)
9. Joint Industrial Council (JIC)
10. American Society of Mechanical Engineers (ASME)
11. Underwriters Laboratories Inc. (UL)
12. Institute of Electrical and Electronic Engineers (IEEE)
13. American Institute of Steel Construction (AISC)
14. Turfgrass Producers International.

B. The Contractor shall provide written certification that the accessories provided under this Specification have been designed in accordance with these specifications and are 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.

1.04 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents. Warranty shall be provided for the complete Rotary Press Package as a unit.

PART 2 - PRODUCTS

2.01 ROTARY PRESS SYSTEM

2.01.1 ROTARY PRESS

The Rotary Press is supplied with one (1) dewatering channel dewatering channels and can accommodate two future dewatering channels. Each channel has a diameter of 36 inches (900 mm). Flocculated sludge is fed at a low, constant pressure not exceeding 7 PSI (48 kPa) into the channel where it is dewatered.

The required number of channels is determined by the flow conditions, quality of the sludge, the dryness of the cake, the filtrate quality and economic, dimensional and maintenance considerations.

The rotary press includes at least the following components:

A Drive System
B Dewatering channels
C Rotary Press base
D Cake outlet chutes

A. DRIVE SYSTEM

a. SPEED REDUCER: The speed reducer shall be foot mounted type with spiral bevel and helical gears. The speed reducer shall be fabricated according to ANSI/AGMA 6010 standard with a robust cast iron housing. The bevel gears will have a minimum of AGMA quality of 9 and the helical gears a minimum of AGMA 11. Output shaft shall be made of steel with a minimum yield of 60200 PSI (415 MPa). Output shaft will have a minimum diameter of 6 3/16” (158 mm). The speed reducer shall be mounted on a steel base epoxy painted (see section 3.1 for painting). No parts of the speed reducer, including gearbox seals shall be in direct contact with either the sludge filtrate or cake. The output seal shall be an integral part of the speed reducer housing; there shall be no bolt-on output cover to cause leakage, shaft or gear misalignment.

b. MOTOR: The electric motor shall be 460V, 60Hz, 3 ph, 1800 RPM totally enclosed fan cooled (TEFC), 5 HP (3.7kW), "C" flange, NEMA Premium Efficiency, service factor 1.15, insulation "F" class, design "B". The electrical motor is directly coupled to the speed reducer. UL approved. The electric motor will be directly coupled to the speed reducer using a "Nema C" flange.

B. DEWATERING CHANNELS The dewatering channel of the Rotary Press shall be mounted on the gear reducer output shaft. Each channel shall be an independent self-contained modular unit which can be interchanged with other Rotary Presses of the same model. The low-speed shaft seal of the speed reducer will, in no way, act as a filtrate seal for the dewatering channel. All material in direct contact with the flocculate sludge or with the cake shall be in stainless steel or plastic made. Each of the channels will be composed of the following elements:

a. FILTRATION ELEMENTS: The filtration elements shall be made of stainless steel and be hard chrome plated for wear resistance. The filtration elements shall be a non-clogging design which does not require wash water during operation. Filtering element shall be manufactured from thin perforated 316 Stainless steel plate. Filtering element made from wire or wedge wire are not acceptable.

b. SCRAPERS: To clean the filtration elements, each channel shall be equipped with six (6) stainless steel scrapers.

c. FILTRATION WHEELS: The wheels shall be made of mechanically welded stainless steel ASTM A240 / ASME SA240, Type 304L HRAP or equal. The casting will have wall sections with a minimum thickness of 1/2” (12 mm), so designed to withstand internal pressures of up to 300 PSI (2069 kPa). Contact surfaces for the seals shall be made from polished stainless steel and have a surface finish from 16 to 32 RMS.

d. DEFLECTOR: Deflector shall be fabricated from a molybdenum disulphide-filled nylon (Nylatron).

e. FIBERGLASS GLAND COVERS, BUSHINGS AND SEALS: Each gland cover shall be identical and will act as gland to maintain the seal in proper position. The gland covers shall be made from 1/4" (6 mm) thick minimum fiberglass with a minimum of 3 to 6 layers depending on the cover section. This cover shall be used to compress the UHMW gland cover seal between the housing and filtration wheel. The cover will have an outlet in it lower section to drain the filtrate. An additional opening is made for the outside wheel wash water system connection and air bleeding device. For inspection or maintenance, an opening port is located at the rear portion of the cover to permit easy access.Two (2) UHMW bushings will guide the gland cover on the filtration wheel. Sealing shall be assured by one (1) outside lip seal, four

(4) "O-rings": two (2) between bushings and the filtration wheel, and two (2) compressed between the gland cover and the bushing.

f. HOUSING: Each housing is made from 5/8” (16 mm) thick Stainless Steel 304L. The surface in direct contact with the cake shall be stainless steel lined. Housing is supported by the filtration wheel through a set of bushing. Rotating of the housing is restricted by a torque arm, connecting the channel housing to the gear reducer base support. Each housing is interchangeable with other Rotary Presses of the same series.

g. WASH SYSTEM: The wash system shall be provided for use as a daily cleaning of the inside of the channel(s) and the outside of the filtration wheel(s).

    i. One (1) wash manifold is located inside the channel at the sludge inlet. This manifold is made of a stainless-steel tubing assembly, equipped with twenty-eight (28) flush type stainless steel sprinklers.

    ii. One (1) set of 2 manifolds (one set for each filtration wheel) consisting of four (4) sprinklers shall be located in between the filtration wheels and the gland covers. Each manifold is made of stainless-steel fittings and Brass flat jet sprinklers.

    iii. For maintenance purposes, the manifold assembly is fixed to a mounting plate bolted and sealed to the gland cover. All sets of nozzles detach from the water supply using a quick disconnect system for easier maintenance. The system is easily removable from an outside access.

    iv. The system must be equipped with a check valve to prevent the back flow of sludge into the wash system.

    v. Provide the washing system with clean water only.

h. FILTRATE COLLECTOR: Each channel shall be equipped with a removable filtrate collector. Filtrate collector shall be made of low linear density polyethylene (LLDPE). Filtrate outlet connection shall be 7.5" (190,5 mm) dia. Each filtrate collector will include two (2) sampling ports to sample filtrate. Sampling port shall be closed by a removable plug.

i. FILTRATE COLLECTOR MANIFOLD: Each filtrate collector shall be piped to a manifold with a flexible connection. The manifold shall be made with Ø6" (152 mm) PVC schedule 80 piping. The manifold outlet can be oriented toward either side of the Rotary Press longitudinal axis for layout optimisation purpose.

C. ROTARY PRESS BASE: The base shall be fabricated from bend 3/8" (9,5 mm) thick epoxy painted steel plate. Base shall be a close shape to optimize rigidity and spread the load evenly to the supporting floor. Anti rotation device fixations are integrated to the base to facilitate the installation.

D. CAKE OUTLET CHUTES: Every cake outlet will have a chute with an inspection door. The chute shall be made in low linear density polyethylene (LLDPE). A hole for mounting the cake sensor is provided as well as a bracket to be mounted on the side to facilitate installation of the safety sensor.

2.01.2 FLOCCULATOR AND FEED MANIFOLD

A. FLOCCULATOR

a. Mechanical agitation using a pressurized vessel is required before the Rotary Press to assure a proper flocculation. Static mixing device or piping used as static mixer is not acceptable. Static mixing solutions are not considered equivalent to a dynamic mixing solution.

b. The flocculator model 20-300-900 shall be designed with a tank capacity of 17 gallons (64,3 liters) and for 100 PSI (690 kPa) pressure and a maximum temperature of 140 F (60°C). The body and bolted cover shall be fabricated of epoxy painted carbon steel. The thickness of the body shall be 3/8" (9,5 mm). Top cover plate shall be fabricated from 1 1/4" (32 mm) epoxy painted carbon steel. Three lifting lugs shall be supplied to facilitate handling.

c. The agitator shall be variable speed and driven by a gear motor, helical type, hollow shaft, Nord Gear model SK0282. Hollow shaft diameter shall be 1 3/16" (30 mm), 4.79 to 1 ratio, 1 HP (0.75kW), NEMA Premium Efficiency motor, 460V, 60Hz, 3 ph, 1800 RPM, continuous duty, Insulation class F, CSA, CE & UL approved.

d. The seal at the agitator shaft and the flocculator cover will consist of two (2) lip seal contacts with grease cavity in between. A grease fitting will allow the cavity to be lubricated. The shaft seal wear sleeve shall be fabricated from stainless steel. The wear sleeve shall be polished to a surface finish of 16 rms and shall be hardened by nitriding.

e. The flocculator will have the following connections:

i. Sludge inlet
ii. Sludge outlet
iii. Pressure sensor fitting
iv. Wash water connection
v. Polymer connection
vi. Air purge
vii. Spare inlet Ø3/4" (19 mm)

f. The sludge inlet and outlet connections shall be 3 inches (76 mm) diameter with machine groove to adapt type 77 Victaulic coupling or equivalent.

g. Threaded connections for service and instrumentation shall be located on the inlet manifold of the flocculator.

h. The flocculator shall be equipped with an air breather. The air breather shall be located at the top of the flocculator and hook up to the potable water line for occasional back wash and to the drain line to collect any sludge leak. Breather shall be made of PVC.

B. FEED MANIFOLD

a. PIPING FOR FLOCCULATED SLUDGE:

i. All the piping and its accessories are designed to withstand a pressure of 100 psi (690 kPa).

ii. The piping between the flocculator and the Rotary Press shall be made of schedule 10, stainless steel conforming to ASTM A-312 TP 316.

b. PIPE FITTINGS

The pipe fittings shall be grooved end type as described below:

Factory installed Sludge feed lines	Style 77 Victaulic joints or equivalent
Rigid joints on flocculator	Style 07 "Zero Flex" Victaulic joints or equivalent
Flange-to-flange joints	Style 741 "Vic-flange" or equivalent
Field installed Sludge feed lines For butt or field adjust joint coupling (without groove)	Victaulic style 99 "Roust-A-Bout" or equivalent

c. VALVES AND ACCESSORIES: All valve(s) shall be compatible with the nominal operating pressures of the different systems and shall be designed to resist the operating temperatures and the contained fluids. The valves shall be of equal diameter as the piping except if indicated otherwise.

i. AUTOMATIC SLUDGE FEEDING AND RECIRCULATION VALVE:

1. Two pneumatically actuated valves shall be installed on the sludge line between the rotary press and the flocculator. The valve shall meet the following characteristics:

Valve:

Type	Two-way ball valve type Full port (mandatory)
Size diameter	3'' (76 mm)
End connection	ANSI 125# Flanged, raised face
Body material and facing	Cast Iron/A126 Class B
Ball material	Cast Iron/Teflon® Fused
Stem	Stainless steel
Seat ring	RPTFE 15% GF
Manufacturer	Quality Certified Valve, American Valve, Jamesbury, Sure Flow, Famco or equivalent
Dimensional standard	ANSI B16.10
Actuating Mounting Pad	ISO 5211

Actuator:

Type	Manual lever (optional automated pneumatic valve available upon request)
Nominal torque	86.6 lbs ft (117.4 Nm) at 80 PSI (550 kPa)
Degree of protection	NEMA 4/4X and IP67
Manufacturer	FESTO or equivalent
Operating Medium	Compressed air to ISO 8573-1:2010 [7:4:4]

Position indicator:

Type	Visual position switches
Switches	SPDT (normally closed / normally open)
Degree of protection	NEMA 4/4X and IP67
Manufacturer	FESTO or equivalent

2. Sludge feed and recirculation valves shall be piloted by solenoid valves located in the Rotary Press Junction Box (ref. section 4.3.6). The valve body shall be made of anodized die cast aluminium and will have an insulation rated IP65. The working pressure shall be in the range of 29 to 116 PSI (200 to 800 kPa). The solenoid valve with manual override shall be 24 VDC. Solenoid valve shall be Festo or equivalent.

ii. CHANNEL ISOLATING VALVE

1. At the inlet of each channel, a shut-off valve shall be supplied. The valve shall meet the following characteristics:

Valve:

Type	Two-way ball valve type Full port (mandatory)
Size diameter	3'' (76 mm)
End connection	ANSI 125# Flanged, raise face
Body material and facing	Cast Iron/A126 Class B
Ball material	Cast Iron/Teflon® Fused
Stem	Stainless steel
Seat ring	RPTFE 15% GF
Manufacturer	Quality Certified Valve, American Valve, Jamesbury, Sure Flow, Famco or equivalent
Dimensional standard	ANSI B16.10
Actuating Mounting Pad	ISO 5211

Actuator:

Type	Manual lever (optional automated pneumatic valve available upon request)
Nominal torque	N/A (manual)
Degree of protection	N/A (manual)
Manufacturer	N/A (manual)
Operating Medium	N/A (manual)

Position indicator:

Type	N/A (manual)
Switches	N/A (manual)
Degree of protection	N/A (manual)
Manufacturer	N/A (manual)

2. Channel isolating valves shall be piloted by solenoid valves located in the Rotary Press Junction Box (ref. section 4.3.6). The valve body shall be made of anodized die cast aluminium and will have an insulation rated IP65. The working pressure shall be in the range of 29 to 116 PSI (200 to 800 kPa). The solenoid valve with manual override shall be 24 VDC. Solenoid valve shall be Festo or equivalent.

iii. CHANNEL WASHWATER VALVE

1. For automatic control purposes, a pneumatic actuator shall be installed to control the wash water valve to each individual channel. The valve shall meet the following characteristics:

Valve:

Type	Two-way ball valve type Full port (mandatory)
Size diameter	1 inch (25,4 mm)
Body material and facing	Type 316 stainless steel
Maximum pressure	1000 PSI (6,9 MPa)
Manufacturer	C.F.F. model no. SS-3DM or equivalent

Actuator

Type	Pneumatic spring return type Aluminium anodized body
Manufacturer	FESTO or equivalent

2. Wash water valve shall be piloted by solenoid valve located in the Rotary Press Junction Box (ref. section 4.3.6). The valve body shall be made of anodized die cast aluminium and will have an insulation rated IP65. The working pressure shall be in the range of 29 to 116 PSI (200 to 800 kPa). The solenoid valve with manual override shall be 24 VDC. Solenoid valve shall be Festo or equivalent.

iv. OTHER VALVES

1. All other valves other than the one above shall meet the following characteristics:

Valve:

Type	Two-way ball valve type Full port (mandatory)
Size diameter	As required
Body material and facing	Type 316 stainless steel
Seat material	PTFE

Manufacturers	Quality Certified Valve, American Valve, C.F.F., Jamesbury, Trueline, H&P, Famco or equivalent

Actuator

Type	Manual lever

d. POLYMER CHECK VALVE: A stainless steel 1" (25.4 mm) NPT check valve shall be installed on the polymer line to prevent sludge from entering the polymer feed line. The check valve will start to open at 0.5 psi (3,4 kPa) and shall be fully opened at 1.0 psi (6,8 kPa). The valve shall be spring assisted for silent closing and minimizing the effect of water hammer. The valve temperature limit shall be 20 to 400°F (-29 to 204°C). A351-CF8M body (SS316), ANSI class 600, PTFE gasket, metal to metal seat material. The model shall be ISLIP FLOW CONTROLS model no. SC600TSSSSM or equivalent.

e. FLOCCULATED SLUDGE SAMPLER: A flocculated sludge sampler shall be supplied. The device shall consist of a transparent PVC tube to inspect the texture of the flocculated sludge. A 3/4" (19 mm) vent and 2" (50 mm) sludge inlet and sludge draining valves will allow filling and draining the sampler without dismantling or adding any pipes, tubes or plugs. A 3/4" (19 mm) vent shall also be installed for wash purpose. The sampler shall be easily removable for maintenance.

f. WASHWATER PRESSURE GAUGE: A pressure gauge shall be installed at the flocculator on the wash water line. The pressure gauge shall be a 2-1/2" (63,5 mm), liquid filled. The scale shall be 0 to 160 psi (0 to 11 bars).

2.01.3 MISCELLANEOUS

A. PAINTING AND PROTECTION

a. PAINTING AND PROTECTION FOR NON-WETTED COMPONENTS MADE OF CARBON STEEL COMPONENTS

i. Surface preparation:

1. Near white blast cleaning according to SSPC-SP10 for the equipment's.

ii. Primer:

1. Type: Epoxy Resin (high built) Carboguard 893

2. Note: According to the ONGC-1 GP165A Standard (US equivalent Standard SSPC Paint No. 22)

3. Dry thickness: 6 mils (152 µm) min.

iii. Finish coat:

1. Type: Polyurethane

2. Color: Glass Shield Blue # 2862044 Carbothane 134HG blue

3. Dry thickness: 1.5 mils (38 µm) by layer (2 layers) = 3 mils (76 µm) min.

iv. Total paint thickness: 9 mils (229µm) min.

b. PAINTING AND PROTECTION FOR WETTED COMPONENTS MADE OF CARBON STEEL

i. Surface preparation

1. Near white blast cleaning according to SSPC-SP10

ii. Primer

1. Type: Epoxy Resin (high built) Plasite # 7122

2. Note: According to the ONGC-1 GP165A Standard (US equivalent Standard SSPC-Paint No. 22)

3. Dry thickness: 9 mils (229µm) min.

c. SURFACE PREPARATION FOR STAINLESS STEEL COMPONENTS

i. All components are made out of stainless steel shall not be painted.

d. POLYMER BASED OR PETROLEUM BASED COMPONENTS

i. All components are made out polymer based of petroleum-based product shall not be painted.

B. MATERIALS

a. The steel used in the construction will meet the following standards:

i. Tubing: ANSI 304L, ASTM A-269 ou ASTM A 312
ii. Structural shape: CSA G40.21 - 50W (US equivalent ASTM A 572)
iii. Plate: CSA G40.21 - 44W (US equivalent ASTM A 36)
iv. Sheet: ASTM A569
v. Shaft: ANSI-1045
vi. Stainless steel: ANSI 304L, ANSI 316L

C. SPECIAL TOOLS

a. Special maintenance tools shall be supplied. Those will include a shaft torque wrench and lifting bolt for wheel and housing. The special maintenance tools shall be delivered into a toolbox.

D. FASTENERS

a. All fasteners to be used shall be made according to the ANSI/ASME B18 standards.

b. Except if otherwise noted, ASTM F738M stainless steel bolts and ASTM F836M stainless steel nuts (property class A1-50 for both, or equal) shall be used for all assemblies:

i. Channel housings
ii. Gland covers to channel housing
iii. Filtrate collector to channel housing
iv. Channel sludge inlet to the channel housing
v. Anti-rotation plate to the channel housing
vi. Channel housings to outer spacers
vii. Filtration wheels to the inner spacer
viii. Scraper blades to outer spacer
ix. Lifting devices to the channels
x. Wash water system support to gland cover
xi. Deflector
xii. Interior bushing to the gland cover hub
xiii. Sludge transition inlet
xiv. Anti-rotation plate of the channel
xv. Actuator support
xvi. Motor bell housing to the speed reducer input
xvii. Input and output flocculator piping
xviii. Flocculator

c. Except if otherwise noted, ASTM F568M steel plated bolts and ASTM F563M steel plated nuts (property class 4.6, or equal) shall be used for all assemblies below:

i. Speed reducer to reducer baseAll the piping and its accessories are designed to withstand a pressure of 100 psi (690 kPa).

E. WELDING

a. All the welding shall comply the AWS Standard, CSA Standard W59, or equivalent.

F. NOISE LEVEL

a. The noise level of each of the equipment's will not exceed 75 dBA measured at 3 feet (1 meter) from the source.

G. INTERCHANGEABILITY

a. All parts from press or from channel shall be interchangeable with another.

2.01.4 INSTRUMENTATION AND CONTROL

A. BASIC PRINCIPLE OF OPERATION

a. The dewatering unit will consist of one rotary press with its flocculator, along with control devices necessary to maintain an adequate proportion of flow and pressure, resulting in a uniform feed of sludge and diluted polymer to the press.

b. The feed sludge is pumped to the flocculator as to maintain a constant pressure at the flocculator inlet. To accomplish this, the rotating speed of the feed sludge pump will be adjusted according to the internal pressure of the flocculator as to maintain the pressure close to the set value.

c. The diluted polymer is pumped to the flocculator in such a way as to obtain a specified polymer-sludge dosage. The dosage is controlled by adjusting the speed of the diluted-polymer pump and is a function of the speed of the sludge pump, and a set value entered by the operator. From the flocculator, the flocculated sludge is fed into each of the channels of the Rotary Press.

d. The channel outlet pressure is controlled by modulating a restrictor device at the cake outlet. The applied air pressure of the restrictor's actuator is controlled to maintain a constant outlet pressure.

e. A local control cabinet is used to operate the system and to change the basic parameters.

f. The control panel shall be cULus certified. All dewatering equipment and peripheral need to be controlled by the Rotary Press Control Panel for better integration.

B. INSTRUMENTATION

a. FLOWMETERS

i. Sludge flowmeter:

1. The sludge flowmeter shall be installed at the flocculator inlet.

2. The instrument shall meet the following specifications:

Type	Electromagnetic
Linearity error	±0,5%
Diameter/measuring range	3" (75mm) - 24-800 gpm (5,5 - 181,6 m3/h)
Process temperature	-4°F to 122°F (-20°C to 50°C)
Electrical connection	1/2" NPT
Process connection	Flange type ASME B16.5
Display/operation	Two line display with backlit / push button
Output signal	4-20mA
CSA/FM approval class	Class 1 division 2
Liner material	Polyurethan
Electrode material	316L SS
Protection	IP67/Nema 4X, IP68/Nema 6P
Company	Endress & Hauser or equivalent
Serie	Proline Promag W10 or equivalent

ii. Polymer flowmeter:

1. The polymer flowmeter shall be installed at the flocculator inlet.

2. The instrument shall meet the following specifications:

Type	Electromagnetic
Linearity error	±0,5%
Diameter/measuring range	1" / 5-80 GPM (1,1 - 18,1 m3/h)
Process temperature	-4°F to 160°F (-20°C to 90°C)
Electrical connection	1/2" NPT
Process connection	Flange type ASME B16.5
Display/operation	Two line display with backlit / push button
Output signal	4-20mA
CSA/FM approval class	Class 1 division 2
Liner material	PTFE
Electrode material	316L SS
Protection	IP67/Nema 4X, IP68/Nema 6P
Company	Endress & Hauser or equivalent
Serie	Proline Promag W10 or equivalent

b. PRESSURE INDICATOR TRANSMITTER

i. The inlet pressure gauge and transmitter shall be installed at the flocculator inlet.

ii. The instrument will meet the following specifications:

Type	Digital pressure transducer, capacitive, ceramic
Linearity error	± 0.075 %
Process temperature	-40°F to 302°F (-40°C to 150°C)
Operating pressure range	0-30 PSI (0-200 kPa)
Proof pressure (Without any damage to the transducer)	900 PSI (6205 kPa)
Electrical connection	1/2" NPT
Calibration	0-30 PSI (0-207 kPa)
Output	4-20mA
Process connection	1/2" NPT
Protection	I, II, III Division 1
Diaphragm material	Ceramic
Company	Endress & Hauser or equivalent
Serie	Cerabar PMC71B or equivalent

c. OUTLET PRESSURE CONTROL

i. Cake outlet pressure shall be controlled by air pressure on the bellows actuating the vertical restrictor.

ii. Adjustable airline pressure regulator shall be used to control the outlet pressure. Each channel will have its own in line air regulator. Regulator shall be relieving type, pressure range 0 to 100 PSIG (0 to 690 kPa), 1/4 inch port, with 150 PSIG (1 MPa) pressure gage. Regulator shall be FESTO Model no. MS4N-LR-1/4-D6-AS.

iii. For automation purposes, Electro-pneumatic transducer shall be supplied with the control system and shall be FESTO Model no. VPPE-3-1-1/8-6-420-E1 or equivalent.

d. CAKE CHUTE SENSORS

i. Each channel shall have two (2) sensors. One to monitor the loss of cake production and the second to monitor the opening of the

inspection doors. Each sensor is mounted on the cake hopper. To facilitate maintenance, the sensors will be equipped with a quick connector.

ii. Cake sensor

1. Sensor shall be a capacitive type, made by Schneider Electric, Model no. XT218A1PCM12 or equivalent.

iii. Safety sensor, inspection door

1. Sensor shall be a magnetic type, made by PILZ, Model no. 506226 or equivalent

e. LOAD SENSING

i. A load sensing device shall be installed as a torque limiter on each channel.
ii. The load sensing device shall meet the following specifications:
iii. Type: Load cell
iv. Rated capacity: 5000 lbs (2268 kg)
v. Excitation voltage (Maximum) 5-12Vdc (15Vdc)
vi. Insulation resistance:≥5000MΩ
vii. Safe overload:150%
viii. Non-repeatability: ±0.02% of FSO
ix. Combined error: 0.05% full scale
x. Compensated temperature range: 14 to 104°F (-10 to +40°C)
xi. Operating temperature range: -40 to 176°F (-40 to 80°C)
xii. Cable length: 20 feet (6 meters)
xiii. Material: Nickel plated alloy steel
xiv. Protection: IP65
xv. Company Vishay
xvi. Model: 363-D3-5K-20P1 or Fournier Industries approved equivalent

C. PROCESS CONTROL CABINETS

a. PREWIRED CONTROL CABINET: Prewired control with connection to field devices and field wiring through terminal strips, in a Nema 12 enclosure shall be provided. As per customer requirement, the control shall operate on 460V, 60Hz, 3ph. The control cabinet shall include the following:

i. Back-panel mounted components and devices consisting of (but not limited to) the following:

1. Main fused disconnect switch
2. Circuit breakers for PLC, HMI and others control devices
3. Line reactor
4. Variable frequency drive (VFD)
5. Programmable logic controller (PLC)
6. Filter and surge protective device for control voltage
7. DC power supply
8. Relay
9. Safety relay
10. LAN modem (Internet communication)

ii. Door mounted components consisting of (but not limited to) the following:

1. Power warning alert indicator
2. Operating handle for main fused disconnect switch
3. Emergency stop push button
4. Human machine interface (HMI)

iii. Control cabinet air conditioning system shall be supply if required by the heat load calculation vs room temperature. If required, the air conditioning system shall be Hoffman Proair Harsh Environment CR23 or equivalent.

b. PROGRAMMABLE LOGIC CONTROLLER (PLC)

i. A programmable logic controller shall be used to control the Rotary press and the related equipment. PLC shall have Ethernet communication to communicate with the VFD, HMI and the plant network.

Programmable logic controller (PLC):
The PLC will have the following specifications:

Processor unit	Communication ports: RJ45 Nominal input power: 24Vdc Operating temperature: 32 to 140°F (0 to 60°C)
Analog inputs	Input type: current Power supply, 24Vdc Selection 4-20mA
Analog outputs	Output type: current Power supply, 24Vdc

	Selection 4-20mA
Discrete inputs	Discrete input type: sink/source Qty: 16 points Field power nominal voltage: 24Vdc
Discrete outputs	Discrete output type: source Qty: 16 points Voltage: 24Vdc
Certification	cULus Listed Cl 1 Div 2
Company	Siemens or equivalent
Serie	S7-1500 ET200SP or equivalent

c. HUMAN MACHINE INTERFACE (HMI)

i. A human machine interface shall be used to operate the Rotary press and the related equipment.

Touchscreen operator interface:

The touchscreen operator interface will have the following specifications:

Display type and size	Color TFT LCD (10.1" - 255mm)
Graphic display resolution	1280 x 800
Display colors	16.7 million colors
Touch screen	Multi-touch screen (capacitive)
Operating temperature	0…50 °C (32…122 °F)
Communication ports	1 x RJ45 10/100/1000 Mbps, 2 X USB
Programming memory	10 Mbyte
Memory card type	Expansion via USB flash drive
Input voltage (power consumption)	24VDC (9.3 Watts)
Certification	cULus / CSA
Protection	Nema 4X,12 / IP66
Company	Siemens or equivalent
Model	SIMATIC HMI Unified Basic or equivalent

d. VARIABLE FREQUENCY DRIVE (VFD)

i. Variable frequency drive shall be used to control the speed of the Rotary press and the flocculator. VFD will have overload protection and ramp regulation capability. Run command, status and speed control shall be handle using communication network.

Variable frequency drive (VFD): The VFD will have the following specifications:	
Voltage input	460V, 60Hz, 3ph
Output voltage	Adjustable 0V to rated motor voltage
Input frequency variation	47 to 63 Hz
Communication	Modbus
Operating temperature	-4 to 122°F (-20 to 50°C)
Certification	CE, cULus Listed
Protection	IP20 Nema/Open
Company	Schneider Electric
Model	Altivar 320 or equivalent
Rotary press rating	5 HP (3.7kW)
Flocculator rating	1 HP (0.75kW)

e. LAN MODEM (INTERNET COMMUNICATION)

i. A LAN modem is used for remote access in case of programming change needs and troubleshooting. This modem uses common internet as communication link.]

LAN modem (internet communication):
The LAN modem will have the following specifications:

Power supply (consumption)	12 to 24Vdc +/-20% (10W)
Communication port	1 SubD9 serial port RS232 (RS485 not isolated) 1 RJ45 Ethernet 10/100 base Tx
Operating temperature	-4 to 158°F (-20 to 70°C)
Certification	CE, cCSAus
Company	Ewon or equivalent
Model	Cosy+ Ethernet or equivalent

f. ROTARY PRESS JUNCTION BOX

i. A pre-wired Nema 4X FRP enclosure junction box shall be installed on the rear of the rotary press gearbox. Wash valves as well as sensors installed on the cake chute shall be routed to this junction box and pre-connected to terminal blocks. The Rotary press junction box shall include, but not limited to, the following components:

1. I/P converter
2. Air filter and regulator

3. Solenoid valve for pneumatic control of sludge feeding and recirculation valve
4. Solenoid valve for pneumatic control of wash water valve

ii. To ensure proper air quality and inlet pressure control to system, an air regulator and an air filter are furnished and installed on the air inlet supply of the Rotary press junction cabinet. The air regulator and air filter shall be rated for air purity class per ISO 8573-1:2010[7:4:4], high efficiency general purpose protection for a particle removal down to 5 microns, including water and oil aerosols. 1/4" NPT type connection, fully automated drain, maximum pressure 175 PSI, operating temperature between 35 °F & 140 °F (2°C & 60°C), an integrated air regulator shall include a manometer, range 0-175 PSI with lockable rotary knob. Air regulator shall be FESTO Model no. MS4N-LFR-1/4-D7-CRM-AS or equivalent.

g. EMERGENCY STOP PUSH BUTTON

i. An emergency stop push button shall be installed in front of the rotary press and wired to the junction box.

D. PROGRAMMING

a. CONTROL

i. Process parameters and control shall be accessible to the pre-program PLC via operator interface. The operator will have access to the following:

1. Sludge inlet pressure
2. Outlet pressure control
3. Polymer/Sludge ratio
4. Rotary press rotating speed
5. Flocculator agitator speed
6. Automatic System Start/Stop
7. Manual control of each equipment

b. PROTECTION AND ALARMS

i. Programming will include the following protection/alarm:

1. High inlet pressure, stop the dewatering system
2. Zero flow on sludge input flow, stop the dewatering system
3. Zero flow on polymer, stop the dewatering system
4. Cake flush, stop the dewatering system
5. Low air pressure, stop the dewatering system
6. Any motor did not start, stop the dewatering system

7. Preventive maintenance notice, warning only

ii. Programming will include at the minimum the following alarms:

1. Rotary press faulted
2. Rotary press did not start
3. Flocculator faulted
4. Flocculator did not start
5. Sludge pump faulted
6. Sludge pump did not start
7. Sludge pump low flow
8. Polymer pump faulted
9. Polymer pump did not start
10. High inlet pressure
11. Cake flush
12. Low air pressure
13. Preventive maintenance warning

c. OPERATOR INTERFACE SCREENS

i. The operator interface shall be built to give friendly usage to the operator. The following screen page shall be available to the operator:

1. Main Menu page
2. Parameters & Cycle start-stop page
3. Totalizers page
4. Each motor, manual operation page
5. Preventive maintenance advise page

d. STANDARD FEATURES

i. System programming to incorporate the following features as standard control:

1. Individual or grouped channel wash selection (for optimal wash depending on the water supply)
2. Automatic system start at selected time of the day
3. Automatic adjustable delayed system stop

2.02 SHAFTLESS SCREW CONVEYOR

2.02.1 GENERAL REQUIREMENTS

A. These specifications shall be considered as minimum requirements. The Contractor or Equipment Supplier shall add such additional features as are necessary for satisfactory operation and functioning of the conveying equipment.

B. Structural design shall be in accordance with American Institute of Steel Construction AISC Standards.

C. Except as otherwise indicated, welding shall comply with ANSI/AWWA D100 and AWWA C206, and the following:

D. Welding shall be by the metal-arc method or gas-shielded arc method described in the American Welding Society's "Welding Handbook" as supplemented by other AWS standards. Welding shall conform to American Welding Society Structural Code D.1.1-82. Qualification of welders shall comply with AWS Standard AWS D1.198.

E. During assembly and welding the component parts shall be clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall comply with the AWS code. Upon completion of welding, weld splatter, flux, slag and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners on material that is to be painted or coated shall be ground to a minimum of 1/32" on the flat.

F. Material type, thicknesses and dimensions shall conform to the screw conveyor schedule requirements unless otherwise specified or required for structural considerations.

2.02.2 SERVICE CONDITIONS FOR SCREW CONVEYORS

A. Material Characteristics (See Schedule for Details)

B. Operating Conditions and Performance Requirements (See Schedule for Details)

2.02.3 TROUGHS, COVERS, END PLATES, CHUTES AND SLIDE GATES

A. Conveyor Troughs

a. Horizontal and vertical conveyor trough bodies shall be "U" type for horizontal conveyors and "O" type for vertical conveyors with trough dimensions conforming to the requirements of CEMA Standard 300, with exceptions as noted herein. The conveyor trough bodies shall be rolled to shape with both side flanges formed with the trough body. Trough end flanges, welded to each trough section, shall be provided for joining adjacent sections or connecting trough end plates to the trough sections. Each conveyors trough sections must not exceed 8 feet (96 inches) from flange to flange.

b. Conveyor troughs shall be equipped with a wear liner across the entire inside length. The wear liner shall be fabricated of high density UHMW polyethylene. The wear liner shall be provided in 4-foot long sections for ease of

replacement. The wear liner shall be held in place using clips welded to the inside of the trough. Clips shall be placed away from the conveyor spiral path.

c. Each conveyor shall be equipped with a drainage valve at its lower end. The drainage valves must be stainless steel ball valve of 2 inches in diameter.

d. Conveyor troughs for shaftless screw conveyors shall be furnished with anti-floatation devices. Anti-floatation devices shall be installed at a minimum distance of every sixteen (16) feet of conveyor length.

B. Conveyor Covers (U Shape only)

a. A sectional plate shall cover the entire trough, with exception of the inlet chute connections located. Cover segments at inlet chute connections shall extend, on each side, beyond the inlet chute connection and shall be bolted in place. Each cover section shall be not greater than 6-feet in length. The cover segments shall be arranged so that the trough flange and a trough stiffener provide support to each edge.

b. The covers open for maintenance and cleaning purposes. The cover shall be bolted.

C. Conveyor End Plates

a. End plates shall be bolted to the trough end flange. End plates shall be designed to support the drives, bearings and gear reduction assembly.

b. Where shafts penetrate the end plates, the end plate shall be provided to accommodate the stuffing box provided.

D. Conveyor Chutes

a. Trough inlet and discharge chutes shall be bolted to the adjoining equipment as shown on the Contract Drawings. Inlet and discharge chutes shall be supplied with reinforced rectangular or circular flanges.

E. Pneumatically Operated Slides Gates

a. Slide gates on the distributing screw conveyors shall be horizontally mounted. The minimum net opening of the gate shall be equal to the through width in length. Operation of the gate shall be by means of an electric solenoid valve controlling pneumatically operated cylinders supplied by the gate manufacturer. The electric solenoid valve must be or 24 VDC.

b. Pneumatic cylinders shall be sized by the gate manufacturer to operate the gate at a rate of 3-in to 5-in per second using of plant air supply at 80 to 100 psi. Pneumatic cylinder shall de 2 ½ diameter. Piston rod, tie rods, nuts and

fastener to be stainless steel. Cylinder tube made of Aluminum alloy and the inside of the tube to be hardened to 60 RC for wear resistance. Head and cap will be equipped with cushion.

c. Electrically operated solenoid valves and limit switches shall be furnished and installed on the gate and factory piped to the pneumatic cylinder.

d. Air Valves shall be sized to provide the specified gate disc speed. Air valve shall include muffler.

e. The slide gate shall be capable of operation with a full chute of sludge, both opening and closing. The gate will be sliding against two UHMW liners. The end of the gate will close against a UHWM stopper made to seal and profile to prevent the sludge to accumulate between the gate and the body of the valve. An adjustable wiper seal shall also be provided to wipe the top of the gate. The slide gate frame shall be self supporting and is only fixed on the conveyor through by the transition flange.

f. Gate valves shall be as manufactured by VORTEX VALVES, FOURNIER INDUSTRIES or equal.

2.02.4 CONVEYOR DRIVE TRAIN EQUIPMENT

A. The conveyor drive train equipment shall transmit power to the conveyor drive shaft using a shaft mounted speed reducer connected to an electric motor. Drive units shall be rigidly supported to avoid all visible “wobble” movement under any operating conditions. Any leakage coming from the trough passing through the shaft seal shall leak through the adapter end plate to atmosphere rather than into the gear motor.

B. Drive Shaft Assembly

a. The drive end assembly shall consist of the following components.

i. Drive Shaft
ii. Seal plate
iii. Hollow Shaft Gear Reducer

b. The tail end shall consist of the following components

i. Zero Speed Sensor

c. Drive shafts for the shaftless screw conveyors are to be complete with mating connections appropriate for mating to the shaftless screw assembly. The drive shall be of adequate diameter to handle all radial, thrust and torsion loads. The drive shafts shall be mounted to the shaftless spiral by a flanged connection.

C. Drive Motor

a. Drive motors shall be of the high starting torque (NEMA B or C design), TEFC, squirrel cage, AC induction type suitable for continuous severe duty service. The motor shall have Class F, MG 1 Part 31.4.4.2 Inverter Duty insulation, and a Class B temperature rise at 40°C ambient temperature. The drive motor shall be high efficiency with a 1.15 service factor.

b. The drive motor shall operate at 1800 rpm nominal speed and be sized to operate without overloading when the screw conveyor is operating at, or below, the design capacity. The minimum motor horsepower shall be as specified on the conveyor schedule elsewhere herein.

D. Speed Reducer

a. The speed reducer shall be a gearmotor enclosed shaft mount, type unit with a double or triple reduction ratio, as may be required. The speed reducer shall mount directly on the driven shaft and utilize a standard CEMA mounting to support structure. We highly recommend Screw Conveyor Package design flange from Nord Gear Corp.

b. The speed reducer sealing system shall be a Quadrilip system that has four components for sealing lubricant inside and contaminants outside of the speed reducer. The system must include a double lip seal, a single lip seal and grease pack barrier (grease lip). The sealing system shall also include diverting ports to avoid any possibilities of contamination to the gear reducer oil, even if the first seals broke down.

c. The speed reducer housing shall be constructed of 1-piece corrosion resistant gray cast iron torsional stiff. All housings bore and mounting faces shall be machined in one step to produce extremely precise tolerances. Thus ensuring accurate positioning of gear teeth, bearing & seals and a longer life of all components

d. All speed reducer gearing shall be of helical design. High speed gears shall be ground and low speed gear skive hobbed. Gears hardness shall be 58 Rc minimum. With an overload capacity of 275%

e. The speed reducer bearings shall be ball or tapered roller type and provide a 50,000-hour B-10 life at the expected design loading rate. All seals shall be double lip, spring-loaded type and made of nitrile rubber. Shaft seals shall be quadrilips two nitrile seals, which consists of 2 sealing lips, a trash guard lip and a grease chamber between the seals.

f. The speed reducer shall be manufactured to Quality Class 8 per AGMA Standard 6001-C88, minimum. The gear reducer shall be selected for AGMA

Class 11 service with a 1.4 service factor based on motor nameplate horsepower.

g. The speed reducer shall be as manufactured by Nord Gear Corp., or equal.

2.02.5 CONVEYOR SUPPORTS

A. The conveyor troughs shall be supported using saddle type supports shaped to the profile of the troughs and extending to a common fixed distance below the centerline of the screw. Saddle type supports shall be located not greater than 16-feet center-to-center. Separate support points shall be provided (when possible) under the drive end and tail end assemblies. These supports are to be bolted to the trough flange.

B. Troughs thickness shall be design to maintain through shape under loading. Transverse stiffeners shall not be used in order to allow easy maintenance of the UHMW liner and for the flight maintenance.

C. Support loadings are to be based on a completely filled trough, weight of the conveyor and the dynamic loading when operating.

D. The Contractor shall coordinate with the Conveyor Equipment Supplier support locations with the facility structural constraints. Access to other process systems and equipment shall not be restricted by the conveyor supports.

E. Each conveyor shall be field shimmed as required to conform to the manufacturer's installation tolerances.

2.02.6 SHAFTLESS SCREW ASSEMBLIES

A. The shaftless screw flights shall be cold rolled spirals fabricated from high strength carbon spring steel bars with a minimum tensile strength of 100,000 psi and a minimum Brinell hardness of 200.

B. Shaftless screw conveyor spiral flights shall be formed in a forming machine to the diameter and pitch required. Each formed section shall be factory welded into full lengths. Where the length of the conveyor precludes shipping, sub-sections of flighting shall be divided into maximum shipping lengths and welded together in the field.

C. Field splicing of flighting sections shall be by full penetration welds done in strict accordance with the manufacturer's instructions using AWS certified welders.

D. Spiral flighting shall be connected to the drive shaft using a flanged connection plate that shall be welded to the spiral on one end. Transition between the flighting and connection flange shall be smooth and fabricated to the tolerances listed below. The drive shaft shall have a matching mating flange and shall be bolted to the flight connection plate.

2.02.7 SAFETY DEVICES AND LIMIT SWITCHES

A. Zero Speed Switches

a. Motion failure alarm unit shall equip each conveyor. The motion sensor shall be a non-contacting type probe. This probe shall be able to read screw rotation outside of the process, by reading disruption of the magnetic field by the ferrous target (flight).

b. The electronic unit shall operate on 120 volts AC power supply and shall be rated NEMA 4X or IP67. The probe signal shall be relay interconnected with a PLC digital input.

c. The zero speed sensors shall be located at the opposite end of drive. The PLC is always counting pulses, without any pulse count a PLC digital output shall be activated for an alarm or shall stop the whole system. Relay switch contacts shall be rated 120 VAC and interlocked with MCC motor starter.

d. Zero speed detection switches shall be Siemens model Sitrans WM100, or equal.

2.02.8 CONVEYORS CONTROL

A. Conveyors shall be controlled by the rotary press PLC and operator interface.

2.02.9 SCREW CONVEYOR SCHEDULE

Identifier	Receiving Conveyor
Conveyor Type	Horizontal, Mono-Directional, Shaftless
Material handle	Cake from discharge from Rotary Press
Mass Flow Capacity	2.0 Wet ton/h
Loading at nominal capacity	45%
Material density	45 lbs / cubic feet
Temperature	40°F to 100°F
Flight nominal diameter	9-inch diameter
Flight Pitch	9-inch pitch
Flight section	2 ½" X ¾"
Flight material	High strength chrome alloy steel, 200 Brinell min
Flight diameter tolerance	+ 0 - 1/4"
Flight pitch tolerance	± 1/4"
Conveyor nominal Length	8.75 ft
Conveyor slope	0 degrees
Trough body	U-Trough 304 stainless 11 gage thick
Trough cover	304 stainless 12 gage thick
Trough end flanges	304 stainless 3/8" thick
Trough end plates	304 stainless 1/4" thick
Support	304 stainless 5/16" thick
Liner	UHMW 3/8" thick
Inlet	#N/A
Inlet type	Inlet cake chutes from Rotary Press
Outlet	One (1)
Outlet type	To Vertical Conveyor
Gear reducer manufacturer	Nord Gear
Gear reducer model	SK2282 SCP
Power	1 HP 480V/60Hz/3ph
Output speed	24 RPM
Special Requirements	2" drain Screw Conveyor Package gear motor flange

Identifier	Incline Conveyor
Conveyor Type	Incline, Mono-Directional, Shafted
Material handle	Cake from discharge of Rotary Press
Mass Flow Capacity	2.0 Wet ton/h
Loading at nominal capacity	100%
Material density	45 lbs / cubic feet
Temperature	40°F to 100°F
Flight diameter	9-inch diameter
Flight Pitch	5-inch pitch
Flight section	Shafted flight 2 ½" X ¼" with sch 80 shaft
Flight material	High strength chrome alloy steel, 200 Brinell min
Flight diameter tolerance	+ 0 - 1/4"
Flight pitch tolerance	± 1/4"
Conveyor nominal Length	17' 8''
Conveyor slope	
Trough body	Tubular O-Trough 304 stainless 10 gage thick
Trough cover	N/A
Trough end flanges	304 stainless 3/8" thick
Trough end plates	304 stainless 1/4" thick
Discharges chutes	304 stainless 1/8" thick
Support	304 stainless 5/16" thick
Liner	N/A
Inlet	One (1)
Inlet type	Receiving Conveyor Outlet
Outlet	One (1)
Outlet type	
Gear reducer manufacturer	Nord Gear
Gear reducer model	TBD
Power	3 HP 480V/60Hz/3ph
Output speed	100 RPM
Special Requirements	2" drain Screw Conveyor Package gear motor flange

2.03 ROTARY PRESS SLUDGE FEED PUMP

2.03.1 GENERAL

A. The equipment covered by these Specifications shall be of standard units of proven ability as manufactured by reputable concerns having long experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed as shown on the Drawings.

B. All equipment shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain.

C. The pumping units required under this section shall be complete. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.

D. Stainless steel nameplates giving the name of the MANUFACTURER, the pump serial number and material code and all other pertinent data shall be attached to each pump, motor, and control panel.

E. All working parts of the pumps and motors, such as bearings, wearing rings, shaft, sleeves, etc., shall be standard dimensions built to limit gauges or formed to templates, such that parts will be interchangeable between like units and such that the OWNER may, at any time in the future, obtain replacement and repair parts for those furnished in the original machines.

F. The nameplate ratings of the motors shall not be exceeded, nor shall the design service factor be reduced when the pump is operating at any point on its characteristic curve at maximum speed.

G. Mechanical equipment, including drives and electric motors shall be supplied and installed in accordance with applicable OSHA regulations. The noise level of motors, unless otherwise noted, shall not exceed 85 dBA measured 3 meters from the unit under free field conditions while operating on utility power.

H. All lubrication fitting shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.

2.03.2 PUMPS

A. General

a. Rotary Lobe Pumps shall be designed to be abrasion resistant for applications in wastewater treatment plants

b. The ratio of the axial length of the lobe as compared to the lobe diameter (length/diameter) shall not exceed 1.0.

c. The pumps shall be of the positive displacement, rotary lobe type, designed to pump wastewater sludge as manufactured by Boerger.

d. All fluid-wetted parts including the mechanical seal shall be replaceable through the quick release front cover without disassembly of coupling, drive unit or the pipe system.

e. 4. The pumps shall be designed to temporarily run dry and to operate in either direction. Oil-quench for protection of the mechanical seal is mandatory. Seal water flush systems are not acceptable.

f. The pumps shall be constructed with an oil-filled intermediate chamber between the pump casing and the gearbox with the following functions:

   i. Oil-Quench (Lubrication and cooling) of the mechanical seals

   ii. Detection of seal failures

   iii. Buffer zone to the sealed timing gear

g. Oil drain of gearbox and intermediate chamber shall be easily accessible with side mounted drain screw. Oil drain under the pump is not acceptable.

h. The rotor/shaft connection shall be oil-lubricated fed by an intermediate chamber and shall not come in contact with the pumped fluid.

B. System and Fluid Conditions

Fluid Name	Sludge
Solids Content	% TS
Capacity	25 to 200 (105 GPM avg)
Discharge Pressure	10 PSI * (To be confirmed with layout)
Suction Condition	Floaded * (To be confirmed)
Temperature	40 °F to 115 °F
pH Value	6 to 8

C. Pump Unit

Model	Boerger PL 200
Motor Power (hp)	5 HP * (To be confirmed with layout)
Motor Voltage (VAC)	480 V
Motor Frequency(Hz)	60
Motor Phases	3
Suction Flange	3” ANSI 150-lb

Discharge Flange	3” ANSI 150-lb
Speed control	With VFD Powerflex 535

D. Pump Construction

a. The pump casing shall be manufactured in a single block. Multiple piece design pump casings held together by screw connections are not acceptable.

b. The rear of the pump casing and the front cover shall be protected with replaceable protection plates. The front cover protection plate shall be reversible.

c. The pump casing shall be equipped with radial pump casing protection plates, which are less expensive and will eliminate the pump casing as a spare part for reduction of the Life Cycle Cost of the pump unit. Radial liners allow the pump casing to be brought back to factory tolerance. Pump casings without radial liners are not acceptable.

d. The quick release cover shall be held in place by four eye nuts. The stationary threaded studs shall keep the front cover on the same level as the pump casing in the process of opening the pump for easy handling.

e. Rotors shall be tri-lobe screw rotor design and shall consist of a non-sludge-wetted cast iron core entirely coated with abrasion-resistant elastomer. Stacking of lobes is not acceptable due to maintenance difficulty and possibility of shaft wear. Rotors shall be keyed to the shaft and secured with one central screw to a cylindrical thread inside the shaft. The cast iron core of the rotor shall be equipped with a female thread to enable the removal of the rotor from the shaft with ease. Rotor/shaft designs with a cover disc and/or spring washers are not acceptable.

f. The shafts shall be non-sludge-wetted. The rotor/shaft connection shall be lubricated with quench fluid of the intermediate chamber. The shafts shall be timed in their rotation by straight cut timing gears running in a separate oil chamber, which also contains the ball and roller bearings for each shaft. Sludge wetted rotor/shaft connections are not acceptable.

g. The pumps shall be fitted with maintenance free, quenched mechanical seals. The seals shall be operating in a common oil-filled intermediate chamber (Quench for lubrication and cooling). Purge systems for the seals are not acceptable. The rotating holding bushing shall be locked in a fixed radial position by a keyway that also holds the rotor in place. Seal designs that open during rotor replacement are not acceptable.

h. Bearings and timing gear shall be located in a common oil-filled cast iron gearbox, fitted with a built in sight glass to monitor oil level. The timing gear

shall maintain non-contact between the rotors. Bearing life to be designed for L-10 bearing life rating of 100,000 hours at design conditions.

i. Suction and discharge connections shall be according to the drawings.

j. Pump and drive fitted on common base, made from galvanized steel. Coupling guard shall be according to OSHA standards and shall be painted orange.

2.03.3 RECOMMENDED SPARE PARTS

A. One (1) set of mechanical seals and o-rings for each pump model

B. One (1) set of lobes and o-rings for each pump model

C. One (1) set of axial protection plates for each pump model

D. One (1) set of radial liners for each pump model

E. One (1) multi-tool for each pump model

2.03.4 MOTORS

A. Each unit shall consist of a pump with a gear reducer and 1800 rpm electric motor.

B. The motor shall be according to the appropriate specification section.

2.04 ROTARY PRESS COMPRESSED AIR SYSTEM

Packaged system supplier shall additionally supply a compressed air system as follows:

2.04.1 COMPRESSOR

A. Brand: Makita

B. Model: MAC2400

C. Air flow: 4.2 SCFM. @ 90PSI

D. Maximum Working pressure: 130 PSI

E. Power : 2.5 HP

F. Voltage: 120 Volts – 60 Hz – 1 Ph

G. Compressor Type: Single stage

H. Control: Start-Stop Pressure Switch

I. Cooling: Air

J. Air intake: Admission filter

K. Construction: Cast iron crankcase/cylinders

L. Lubrication: Oil lubrication pump

M. Security: Totally enclosed motor

2.04.2 TANK

A. Quantity: Two (2)

B. Capacity: 2.1 Gallons Each (4.2 Gallons Total)

C. Type: Horizontal, Superposed

D. Drain: Manual tank drain

PART 3 - EXECUTION

3.01 PREPARATION

A. Press system siting shall be approved prior to installation to ensure supporting elements are in place and approved, including but not limited to: structural foundations, support piping connection points, electrical and instrumentation connections and/or conduits associated with the press package.

B. Avoid interference with other trades.

3.02 INSTALLATION

A. General

a. Furnish and install all materials and equipment necessary to complete the work.

b. Install equipment to at locations indicated on Drawings.

c. Make piping connections to equipment preventing excessive strain on equipment; install flexible connections where required.

B. Piping, Valves and Appurtenances:

a. Install in accordance with the requirements of Sections **15060 – Piping and Appurtenances** and **15400 - Plumbing**.

b. Install in accordance with electrical requirements detailed in **Division 16.**

END OF SECTION

SECTION 11900
WATER WELL AND
TREATMENT EQUIPMENT

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 a potable water well complete with casing pipe, well cap, power wiring, pitless adapter, submersible pump, service line, pressure tank, gages, lightning arrester, drain valve, relief valve, check valve, pump controller and associated appurtenances. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as indicated 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 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.

C. Related Work Specified Elsewhere:
   1. Section 15050 - Basic Mechanical Materials and Methods
   2. Section 15060 - Piping and Appurtenances
   3. Section 15400 - Plumbing
   4. Section 16050 - Electrical

1.02 SUBMITTALS

A. 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. Well location showing offset distances from proposed building(s) and property lines.
   2. Well casing and grouting material.
   2. Well pump design criteria including materials of construction, pump curve, nameplate information, motor size and type.
   2. Material spec sheets for grout, well screen, pipe, valves, pump controller, and other equipment show on the well pump plan detail.

4. Operating and maintenance instructions and parts lists

B. After the well is dug and prior to setting the permanent pump, submit the water well capacity based on the allowable safe yield of the new well determined by a well pump test.

C. After setting the pump, submit the final well depth.

C. All documents and reports required by GAEPD Standards for Wells and Boreholes including well testing and disinfection reports.

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. ANSI, American National Standards Institute.
2. ASTM, American Society for Testing Materials.
3. AWWA, American Waterworks Association.
4. UL, Underwriters Laboratory.
5. NEC, National Electric Code.
6. OSHA, Occupational, Health and Safety Act.
7. GAEPD Standards for Water Wells.
8. O.C.G.A. 12-5-134 Standards for Wells and Boreholes.

1.04 QUALITY STANDARDS

A. Well Contractor shall be licensed in the State of Georgia and shall assume sole responsibility for providing a complete and operable system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Contractor shall provide written certification that the accessories provided under this Specification have been designed in accordance with these specifications and are 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.

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 WELL PUMP & CONTROL

A submersible, centrifugal pump shall be installed inside the casing either slightly above the highest screen interval or between screen sets. Pumps must not be installed adjacent to screens and shall not be installed at the bottom of the well.

Control of the pump shall be by means of a well pump control panel similar to Phase Technologies SD or equal. The pump shall be started and stopped automatically by water pressure and with the pressure tank maintain a constant pressure to the system and reduce the well pump cycles. Pressure controls shall be adjustable.

2.02 BACKFLOW PREVENTION

An appropriate backflow prevention device and shut-off valve (downstream of the backflow device) must be placed on the above-ground well discharge piping to prevent water from flowing back down the well.

2.03 WELL TANK

Provide bladder style pressure tank for well pump to minimize pressure surges and water hammer effects. The well pressure tanks shall be located downstream of the pump to provide a constant pressure to the system and reduce the well pump cycles. The tank shall be sized for the capacity indicated on the drawings. The tank shall be manufactured by WellXtrol or equal.

2.04 TREATMENT EQUIPMENT

If tests results show low or poor water quality and the presence of high iron, manganese, hardness and/or low pH, the well driller or water quality specialist consultant/subcontractor shall recommend treatment technologies to improve the water quality. These might include an acid neutralizer, softener, sediment filter, and/or sanitizer. The well driller should include an allowance for this equipment for furnishing and installing this equipment.

Allowance for Treatment Equipment **$8,000.00**
(include in well contractor's price)

PART 3 - EXECUTION

3.01 PREPARATION

A. Well siting should be discussed and approved by SCWA prior to commencement of drilling.

B. Avoid interferences with other trades.

3.02 INSTALLATION

A. General:

1. Furnish and install all materials and equipment necessary to complete the work.

2. Install equipment to at locations indicated on Drawings.

3. Make piping connections to equipment preventing excessive strain on equipment; install flexible connections where required.

B. Piping, Valves and Appurtenances:

1. Install in accordance with the requirements of Sections **15060 – Piping and Appurtenances** and **15400 - Plumbing**.

END OF SECTION

SECTION 13000

INSTRUMENTATION, CONTROL AND MONITORING SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements

Requirements specified in Division 1 of these Specifications form a part of Division 13. This Section covers the general requirements for furnishing and installation of the instrumentation, control and monitoring (ICM) system complete in every detail for the purposes specified and shall form a part of the other Sections of Division 13 unless otherwise specified. The other Sections of this Division shall supplement this Section as necessary.

1. Work Included
   a. The intent of Division 13 is to require that the complete Instrumentation, Control and Monitoring System, including all other Sections of Division 13 shall be furnished by a single Control Systems Integrator (CSI) to assure system uniformity, subsystem compatibility and coordination of system interfaces.
   b. Provide a complete and functional Supervisory Control and Data Acquisition (SCADA) system as described herein, as per the Contract Documents, and as shown on the Contract Drawings. The SCADA system shall be capable of monitoring and performing controls (as indicated on the drawings) of a new Wastewater Treatment Facility and Influent pump station including associated equipment. The SCADA system shall provide capabilities of sending text messages and dial the plant operators in case of major equipment faults. All equipment, materials, incidentals, software, supervision, and labor shall be provided under this Contract.
   c. Furnish the tools, equipment, materials, and supplies and perform the labor required to complete the furnishing and installation of, including instrumentation signal and power conduit and wiring not specifically shown on the electrical drawings, validation, start-up and operational testing of a complete and operable ICM system as indicated on the Contract Drawings and as specified herein.
   d. Provide the equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to ensure that the Owner receives an integrated and operational ICM system as herein specified.
   e. Coordinate with the requirements of Division 16 – Electrical, and provide for operator restart of all equipment on restoration of loss-of-power condition. Sequence automatically equipment restart and provide for time delays as necessary to prevent breaker trips on inrush from multiple equipment concurrent starting.
2. As a minimum, the CSI shall perform the following work:

a. Implementation of the ICM system:
   i. Prepare shop drawing submittals.
   ii. Design, develop, and electronically draft loop drawings and control panel designs.
   iii. Prepare the test plan, the training plan, and the spare parts submittals.
   iv. Procure hardware.
   v. Fabricate panels.
   vi. Program the ICM system as shown on the Contract Drawings.
   vii. Perform factory tests on panels.
   viii. Perform bench calibration and verify calibration after installation.
   ix. Oversee and certify installation.
   x. Oversee, document, and certify loop testing.
   xi. Oversee, document, and certify system commissioning.
   xii. Conduct the performance test.
   xiii. Prepare operations and maintenance manuals.
   xiv. Conduct training classes.
   xv. Prepare record drawings.
   xvi. Prepare calibration sheets.
   xvii. Certify the installation of the ICM system.

b. Integration of the ICM system with instrumentation and control devices being provided under other Sections:
   i. Develop all requisite loop drawings and record loop drawings associated with equipment provided under other Divisions and Owner equipment.
   ii. Resolve signal, power, or functional incompatibilities between the ICM system and interfacing devices.

3. Work Not Included
   a. Process piping, installation of in-line instrumentation, i.e., final control elements in process pipelines, air compressors, main air supply headers, and mechanical work as specified in other Divisions.
   b. Electrical power distribution specifically included under Division 16, circuit protection devices, power conduit and wiring indicated, local equipment control stations, and miscellaneous electrical requirements as specified in Division 16.

B. System Responsibility
   1. The ICM system as specified in Division 13 is an integrated system and therefore shall be provided by a competent, qualified CSI who shall have total responsibility for the Work of Division 13. Entire system installation including calibration, validation, start-up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had experience performing similar installations. The System shall be integrated using the CSI's latest, most modern proven design and shall, as far as practical, be by one manufacturer.

2. The Contractor shall perform the Work under this Division 13, through the use of a qualified CSI who shall perform said Work but it shall be understood that this shall not relieve the Contractor from any responsibility under the Contract.
3. The Contractor shall be responsible for the correct installation of all hardware and systems specified in Division 13.
4. The Contractor shall be responsible to see that all instrumentation components of other Divisions, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, alarming devices and appurtenances are compatible and shall function as outlined, and he shall furnish and install such additional equipment, accessories and appurtenances as are necessary to meet these objectives at no additional cost to the Owner.
5. The Contractor shall use the instrument tag and equipment numbering scheme as shown in Contract Documents, for identifying components which are part of this system.
6. Due to the complexities associated with the interfacing of numerous control system devices, the CSI or vendor shall be responsible to the Contractor for the integration of the ICM system with existing devices and devices provided under other Divisions and provide a completely–integrated control system free of signal incompatibilities; this includes providing review and comment to other vendor equipment submittals and overall coordination of the system.

C. Certification of Intent:
1. Fifteen days after notice to proceed, the Contractor shall submit a certification from the selected CSI. The certification shall be typed on letterhead paper of the CSI. The certification shall be signed by an authorized representative of the CSI. The certification shall include the following statements:
a. (Company name) "hereby certifies intent to assume and execute full responsibility to the Contractor to perform all tasks defined under Paragraph 1.01 Scope, in full compliance with the requirements of the Contract Documents."
b. “It is certified that the quotation to the Contractor includes full and complete compliance with the requirements of the Contract Documents without exception."

D. Documentation of Instrumentation Subcontractor Qualifications:
1. General
a. The entire control system installation including panel building, calibration, validation, start-up, operational testing, and training shall be performed by a control systems integrator (CSI) staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.
b. The system shall be integrated using the latest, most modern proven design and shall, as far as practical, be of one manufacturer.
c. The equipment, level of detail, and overall quality of the control system shall be consistent a typical industrial type control system.
d. Overall system performance shall be guaranteed.
e. Software packages shall be latest versions available.

2. System Integrator qualifications:
    a. Where a system integrator other than the listed below is proposed by the contractor, the proposed system integrator shall be approved by the owner prior to the bid.
    b. The system integrator will be evaluated based on the evidence of experience requirements described below.
    c. The following system integrators are pre-qualified to perform the control system work described in Division 13 without the need to submit evidence of experience:
        i. M/R Systems, Norcross, GA
3. System Integrator evidence of experience:
    a. The system integrator shall submit evidence of experience in performing three similar successful projects in the last five years. One of the projects shall currently be in progress or shall have been completed within the last two years.
    b. Evidence shall include a project description, project block diagram, and a contact name, address, and telephone number from the project owner, general contractor, and principal design firm.
    c. The evidence shall link the system integrator's proposed project manager, panel shop or panel builders, systems engineer, programmer, and instrument field technicians to the past projects.
    d. Provide resumes for proposed project personnel.
    e. Provide organization chart for this project.
    f. Provide the following financial data for this and last year. If system integrator is a subsidiary to a parent corporation, provide financial data for system integrator subdivision only:
        i. Financial statement.
        ii. Balance sheet.
        iii. Dun & Bradstreet report.
    g. The Owner may approve or disapprove the use of the System Integrator for this project based solely on the Owner's level of confidence that the Systems Integrator can perform the Work as reasonably supported by the evidence of experience.
4. Training and Certification:
    a. Completion of the following training courses (or appropriate portions thereof) or possession of the following certifications may be substituted for portions of the System Integrator's personnel experience requirements described above.
    b. Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
    c. Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.

d. Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Technical Skills Training program.
e. Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.
f. Training program curriculums as offered by ISA.
g. Training or certification does not satisfy the related project experience requirements described above.
h. Submit training and registration evidence with the above experience evidence.

E. Contract Drawings
1. Information on the Drawings
a. The following information relative to the Work of Division 13 is indicated on the Division 16 Contract Drawings.
i. Location of primary elements, control panels, and final control elements.
ii. Instrumentation signal and power conduit runs between control panels and field instruments and devices.
iii. Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Contractor.
iv. Location of all equipment having alarm and equipment status contacts.
v. Major instrument conduit runs.
2. Information Not on the Drawings
a. The following information relative to the Work of Division 13 may not be shown on the Drawings, but shall be the responsibility of the Contractor to determine, furnish, coordinate with other Trades, and submit for acceptance, based upon the systems specified.
i. Tubing for pneumatic signals, and/or power between main headers and control panels, field mounted primary elements, field instruments and final control elements.
ii. Number or sizes of tubing required for pneumatic and hydraulic signals.
iii. Point of connection to any hydraulic or pneumatic supply lines.

F. Related Sections include but are not necessarily limited to:
1. Section 01300 – Submittals.
2. Section 01664 – Training.
3. Section 09900 – Painting and Protective Coatings.
4. Section 13200 – Instrumentation, Control and Monitoring System Panels.
5. Section 13400 – Instrumentation, Operator Workstations, Human Machine Interface Terminals, and Programmable Logic Controllers.
6. Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements.
7. Section 16050 – Basic Electrical Materials and Methods.

8. Section 16111 – Conduit.
9. Section 16120 – Conductors and Cables.
10. Section 16473 – Low Voltage Surge Suppression Devices.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. Instrument Society of American (ISA).
      a. ISA S5.4 – Instrument Loop Diagrams.
   2. National Electrical Manufacturers Associations (NEMA).
      a. NEMA – Electrical Code.
   3. American Standard Code for Information Interchange (ASCII).
   4. Institute of Electrical and Electronic Engineers (IEEE).
      a. IEEE C62.41 – Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits.

1.03 SUBMITTALS

A. General.

Refer to the General Conditions of the Contract Documents for required method of preparation and transmittal and conform to requirements herein.

1. Pre-submittal Conference
   a. Arrange a conference with CSI, the Engineer, and the Owner within thirty (30) days after award of the Contract for the purpose of informally discussing in detail and verifying the correctness of the CSI's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by CSI, and duly authorized representatives of the Contractor, Engineer, and Owner.
   b. Submit 4 copies of the following items for discussion at the Pre-submittal Conference:
      i. A list of equipment and materials required for the ICM system and the manufacturer’s name and model number for each proposed item. Identify items by tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether item is "as specified" or "equivalent." Items identified as "equivalent" shall be accompanied by a comparative listing of the published specifications for the item specified and for the item proposed. Equivalent items shall only be accepted by the Engineer if the specified item is no longer manufactured.
      ii. A list of proposed clarifications to the Contract Documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the Engineer.
      iii. A sample of each type of submittal specified herein.

iv. A flow chart showing the steps to be taken in preparing and coordinating each submittal.

v. A bar-chart type schedule for all system related activities from the Pre-submittal Conference through start-up and training. Dates of submittals, design fabrication, programming, factory testing, deliveries, installation, field testing, and training shall be shown. The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.

vi. An overview of the proposed training plan. The Engineer will review the overview and may request changes. All changes to the proposed training shall be resolved at the Pre-submittal Conference. The overview shall include the following for each proposed course:

a) Course title and objectives.

b) Prerequisite training and experience of attendees.

c) Course content – a topical outline.

d) Course duration.

e) Course format – lecture, laboratory demonstration, etc.

vii. A preliminary copy of the ICSI Qualification submittal.

c. Take minutes of the Pre-submittal Conference, including all events, questions, and resolutions. Before adjournment, all parties must concur with the accuracy of the minutes and sign accordingly.

B. Shop Drawings

Before proceeding with any manufacturing, submit Shop Drawings for acceptance in complete bound sets indexed by specification number. Describe the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Schematics shall be complete with tag and terminal numbers. Submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing equipment and tag numbers on panels. Submit panel graphic drawings where applicable. Include material specifications lists where applicable. Include a draft of the theory of operation for relay logic circuits including those implemented via programmable controllers. Submit detailed field instrument installation drawings for each instrument.

C. Design Related Submittals

1. In accordance with the requirements of Section 01300 - Submittals, provide the following submittals:

a. Catalog Cuts

i. Catalog information, descriptive literature, wiring diagrams, and shop drawings shall be provided for all devices, whether electrical or mechanical, furnished under Division 13. This includes, but is not limited to, primary

elements, transmitters, analytical equipment, gauges, valves, controllers, indicators, power supplies, switches, lights, relays, timers, etc.

2. Component Data Sheets
    a. Data sheets, specification sheets, and an instrument list shall be provided for components provided under this Section. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., part numbers, scales, ranges, service, materials of construction, component location, options, and the individual tag number as noted in the Contract Drawings and in Contract Documents.
    b. Include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. More than one tag numbered item may be included on a sheet.
3. Sizing Calculations
    a. 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 computing modules and function generating modules and shall include the actual scaling factors and units used.
4. Panel Construction Drawings
    a. Shop Drawings and Catalog Cuts
        i. Provide detailed shop drawings and catalog cuts for panels, instrument racks, and enclosures. Drawings shall show the location of front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show major dimensions as well as elevations, in inches from the base up, of the rows of components.
        ii. Shop drawings shall indicate location and size of available spare mounting space for rear-of-panel devices. See Section 13200 – Instrumentation, Control and Monitoring System Panels.
        iii. The panel legend shall list and identify front of panel devices by their assigned tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
        iv. The bill of materials shall include devices mounted within the panel that are not listed in the panel legend, and shall include the device tag number, description, manufacturer, and complete model number.
    b. Color Schedule
        i. Provide a color schedule with color samples for control panels for the Owner's selection/approval.
5. Power Requirement and Heat Dissipation
    a. Provide a summary of the power requirements and heat dissipation for control panels. Power requirements shall state required voltages, currents, and phase(s) Heat dissipations shall be maximums and shall be given in BTU/Hr. Summary shall be supplemented with calculations.
6. Panel Wiring Diagrams

a. Wiring diagrams shall be similar to those diagrams shown in the Contract Drawings, but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, hand switches and interlocks.

b. Provide complete terminal identification of external primary elements, panels, and junction boxes that interface directly to the panel wiring being shown. Polarity of analog signals shall be shown at each terminal.

c. External wiring that the electrical contractor must provide and wire shall be shown as a dotted line. Special cables that are provided with the instrument shall be clearly identified.

d. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show each circuit individually. Common or typical diagrams shall not be allowed.

e. Provide panel power wiring diagrams for panels. The diagrams shall include grounding requirements.

7. Interconnecting Wiring Diagrams

   a. Diagrams shall show component and terminal board identification numbers, external wire and cable numbers. The drawings shall show intermediate terminations between field elements and panels (e.g., terminal junction boxes) This diagram shall be coordinated with the Contractor and shall bear his mark showing that this has been done.

8. Loop Diagrams

   a. Provide an individual wiring diagram for each analog loop showing terminal numbers, the location of the DC power supply, the location of any dropping resistors, the location and connection of the surge protection devices. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:

   b. Each loop diagram shall be divided into three areas for identification of device locations: panel face, back-of-panel, and field respectively. 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.

9. Instrument Installation Details

   a. The CSI shall review the Contract Documents and develop and submit for review, complete installation details for each field mounted device and panel prior to shipment and installation. Common details, not requiring any modification, may be referenced by an index showing the complete instrument tag number, service, location, and device description. Installation details shall be provided as required to adequately define the installation of the ICM system components.

10. Operator Interface Submittal

    a. This submittal shall cover the specific plant control schemes as well as the details of the plant reports and process graphic displays.

    b. The submittal shall contain the semi-final details of all logs, reports, and process graphic displays. The specifics of what shall appear on each display and what calculations are required to support them shall be developed and submitted.

c. Submitted process graphic displays shall be no smaller than 8.5-inches by 11-inches and in full color.

d. A complete listing of all signals to be collected for long term historical information shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

e. A complete listing of all signals to be collected for trend display shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

11. Process Control Strategy Submittal:

a. The process control schemes shall be developed in a ladder logic diagram or functional block (logic) diagram presentation based on information from the Contract Documents. Included with each diagram shall be:

i. Brief Scope of the Control Function.

ii. Listing of all scanned inputs to the control function.

iii. A short narrative of the control strategy.

iv. Any assumptions made in developing the program.

v. Listing of all inputs and outputs (i.e., AI, DI, AO. DO) from the control function.

vi. Cross reference list of all I/O showing to which I/O modules or software modules they are linked.

vii. Listing of all operator inputs/outputs to and from the control function. Any special CRT displays related to the function shall be illustrated. A description of the operation of any panels shall be described as it relates to the control function.

viii. Failure contingencies shall be described in detail.

ix. A flowchart representing the control strategy.

b. This submittal shall cover all of the associated logic developed under the CSI required to implement the control functions specified.

c. The System Integrator shall submit annotated logic on 8-1/2-inch x 11-inch format and as an ASCII file on compact diskettes for all logic developed. Annotation shall be 3 lines of 6 characters each for every logic contact. In addition, each network or rung shall be annotated so that a non-technical person can read and easily comprehend what control function the rung or network is performing.

d. This submittal shall also include copies of the PLC I/O configuration tables, I/O reference usage table, complete cross reference to specific rung used of all inputs, outputs, internal coils, data registers, and special purpose coils. In addition, any special switch settings or hardware configuration requirements such as com port configurations shall be described in detail and submitted.

D. Test Related Submittals

Provide five (5) copies of the following:

1. Operational Field Acceptance Test (OAT) Documentation.

The CSI shall submit an example of each type of Instrument Calibration Sheet and Loop Status Report that will be used for the OAT.

After acceptance of the examples, the CSI shall prepare Loop Status Report Sheet(s) for each loop and an Instrument Calibration Sheet for each active ICM system element (except simple hand switches, lights, etc.) These sheets shall be submitted after the tests are completed.

a. Instrument Calibration Sheets.

i. Provide a written report to the Engineer on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include all applicable data as listed below plus any defects noted, correction action required, and correction made. Data shall be recorded on prepared forms and shall include not less than the following items:

a) Facility identification (Name, location, etc.)

b) Loop identification (Name or function)

c) Equipment tag and serial numbers.

d) Scale Ranges and units.

e) Test mode or type of test.

f) Input values or settings.

g) Expected outputs and tolerances

h) Actual readings at 10%, 50%, and 90% of span.

i) Explanations or special notes as applicable.

j) Date, time, and weather.

k) Tester's certification with name and signature.

2. Functional Acceptance Test Documentation.

The CSI shall prepare two types of test procedures and forms as follows.

a. Loop Test Documentation

For functions that can be demonstrated on a loop-by-loop basis, the form shall include:

i. Project Name.

ii. Loop number.

iii. Loop description.

iv. Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.

v. For each component: tag number, description, manufacturer, and data sheet number.

vi. Space for sign off and date by the CSI, the Contractor, and the Engineer.

b. Functional Test Documentation

For those functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:

i. Specification page and paragraph of function demonstrated.

ii. Description of Function.

iii. Test procedure description.

iv. Space after each specific test to facilitate signoff on completion of each test.

E. Testing

1. Factory Testing, field Testing, and Final Acceptance Testing shall be in accordance with the requirements of Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements (TBD).
2. System Commissioning Assistance.
   a. Provide the services of a factory trained and field experienced instrumentation engineer to assist Owner's personnel during each startup of the various systems. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

F. Operation & Maintenance Manuals.

Furnish Instruction Manuals and Parts Lists for instrumentation equipment in accordance with the requirements of Division 1 and as noted herein.

1. Schedule.
   a. Deliver manuals not later than the equipment shipment date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver balance of manuals to Engineer.
2. Material Content. Include in the manuals not less than the following applicable information for each instrument, equipment, subsystem and/or control loop. The O&M Manuals shall consist of, at least, the following material:
   a. Bill of Materials.
      i. A listing of all the panels, racks, instruments, components, and devices supplied. Components shall be grouped by component type, with the component types identified in a similar manner to the component identification code used in these specifications. The list shall contain, as a minimum:
         a) Instrument, panel, rack or device tag number.
         b) Description.
         c) Quantity supplied.
         d) Reference to component data sheet and/or catalog cut.
         e) Component type.
   b. Component Data Sheets.
      i. See Paragraph 1.03 C.2 specified herein before.
   c. Catalog Cuts.
      i. See Paragraph 1.03 C specified herein before.
   d. Component O&M Manuals.
      i. An O&M manual shall be submitted for instruments and devices supplied. The O&M manuals shall contain, as a minimum:
         a) Operating procedures.
         b) Installation procedures.

c) Maintenance procedures.
d) Troubleshooting procedures.
e) Calibration procedures.
f) Internal device schematics and wiring diagrams.
g) Shut-down procedures.
h) Component parts list.
i) Detailed circuit operational description including annotated programmable controller ladder diagrams.

e. Spare Parts and Expendables List
i. The spare parts and expendables list shall include not only those items supplied, but also the additional items recommended for successful long term operation.

f. "As-Shipped" Drawings
i. 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:
a) Panel Fabrication Drawings.
b) Panel Wiring and Interconnection Drawings.

G. Final Record Documentation's
1. Reproducible Drawings. Contractor shall submit reproducible's of finished schematics, wiring diagrams and installation drawings to include 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 "RECORD DOCUMENTS", in accordance with the requirements of Section 01700 – Contract Closeout. One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.
a. Loop Diagrams.
1) See Paragraph 1.03 C.8 specified herein before.
b. Panel Fabrication and Wiring diagrams.
1) See Paragraph 1.03 C.4 and 1.03 C.6 specified herein before.
c. Interconnecting Wiring Diagrams.
1) See Paragraph 1.03 C.7 specified herein before.
d. Instrument Installation Details.
1) See Paragraph 1.03 C.9 herein before.
2. Process and Instrumentation Diagrams (P&ID's).
a. The Engineer will supply the Contractor with P&ID's for revisions to reflect the final installed system.
b. The P&ID's shall be updated by the Contractor who may use these drawings for producing the final documentation.

3. Software Documentation. In addition to the reproducible hard copy of drawings and literature generated specifically for the project, Contractor shall submit CD-ROM's to the Engineer with a copy of all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc. Drawing format shall be compatible with AutoCad ver. 2008 or newer. Diskettes 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 "RECORD DOCUMENTS."

H. Training Requirements.
1. General:
    a. Contractor shall provide the services of a CSI factory trained and field experienced instrumentation engineer to conduct group training of Owner's designated personnel in the operation of each instrument system. Obtain Owner's written consent that the training has been adequate. Include instruction covering basic system theory, operating principles and adjustments, routine maintenance and repair, and "hands on" operation. The text for this training shall be the P & ID's, graphic operation interface, PLC and SCADA software, panel wiring diagrams and layouts, and the operation and maintenance manuals furnished under these Specifications.
2. Duration:
    a. Training specific to the system control panel hardware and software. This training shall be for a minimum time period of 30-8-hour days and 6 trips. This training shall be separate from start-up and testing. See Section 01664 – Training.
3. Operator Training:
    a. Operator training shall include instruction in the use of Control Panels and Field Panels furnished.
4. Maintenance Training:
    a. Maintenance training shall include instruction in the calibration, maintenance, and repair required for all instruments.

I. Post-Contract System Support.
1. Maintenance Contract:
    a. Duration.
        i. Provide a 1 year maintenance contract for components furnished starting from the date of acceptance.
    b. Schedule.
        i. Develop a program of preventive maintenance visits that includes verification of instrument performance on a monthly basis and complete calibration of instruments on a semi-annual basis. After every visit, submit to the Owner records of instrument verification and calibration on appropriate forms.

J. Guarantee and Warranties

1. The equipment manufacturers shall warrant and guarantee against defective equipment, workmanship, and materials under normal use, operation and services, unless otherwise noted in other Division 13 Sections shall be for a period of 2 years after acceptance from the final date or final resolution of the Owner acceptance of Work as substantially complete. For equipment bearing a manufacturer's warranty in excess of two years, furnish a copy of the warranty to Engineer with Owner named as beneficiary.

PART 2 - **PRODUCTS**

2.01 HARDWARE REQUIREMENTS

A. Job Conditions.

1. Contract Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Contract Drawings as closely as possible and exercise care (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to accommodate structural features. Verify dimensions and conditions at the project site, and install materials and equipment in the available spaces.

B. Materials and Standard Specifications.

1. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities, instruments supplied by the Contractor, of the same type shall be by the same manufacturer. All panel mounted instruments shall have matching style and general appearance. All meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise required to match existing equipment. This allows the stocking of the minimum number of spare parts.

C. Product Delivery, Storage, and Handling.

1. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element which could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

D. Mountings.

1. Mount and install equipment as indicated. Where not shown, mount field instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with suppliers recommendation. Unless specified otherwise all mounting hardware shall be stainless steel. Where mounted in control panels, mount according to manufacturer recommendations.

2. 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, and catwalks. Such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in Type 316 stainless steel NEMA 4X cases unless otherwise noted.

E. Instrument Identification.

1. 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.
2. Nameplates for panels and panel mounted equipment shall be as specified under Section 13200 – Instrumentation, Control and Monitoring System Panels.
3. Field mounted tags shall be 16-gauge, Type 304 stainless steel with 3/16-inch high characters.
4. 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.
5. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In each case, 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.

F. Electronic Equipment.

1. If the equipment is electronic in nature, provide solid state equipment to the greatest extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Where conduit connection is provided for mounting a surge/lightning suppresser directly to the instrument, the arrestor shall be so mounted. Field equipment shall have a Joslyn (or accepted equal) surge suppresser mounted on the instrument housing, if such mounting is provided on the instrument, otherwise a threaded surge suppresser connection shall be provided on the conduit as close as practical to the instrument. See Section 16473 – Low Voltage Surge Suppression Devices.

G. Equipment Operating Conditions.

1. Equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:
2. Power:
   a. Electrical. 115 VAC +/- 10%, 60 Hz +/-1 Hz except where specifically stated otherwise on the drawings or in the specifications.

3. Field Instruments:
    a. Atmospheric contaminants (All Areas):
        i. Hydrogen Sulfide: 0.1 mg/l.
        ii. Chlorine: 0.01 mg/l.
        iii. Ammonia: 0.5 mg/l.
        iv. Dust: 50.0 µg/m3.
    b. Outdoor Areas:
        i. Ambient Temperature: -20^{O}F to +120^{O}F.
        ii. Ambient Relative Humidity: 10% to 100%.
        iii. Weather: Rain, wind, sun and blowing sand.
4. Indoor Environmentally Uncontrolled Areas:
    a. Ambient Temperature: 40^{O}F to +105^{O}F.
    b. Ambient Relative Humidity: 20% to 80%.
5. Indoor Environmentally Controlled Areas:
    a. Ambient Temperature: 55^{O}F to +85^{O}F.
    b. Ambient Relative Humidity: 20% to 80%.
    c. Short term excursions to temperature limits for non-environmental controlled areas.
6. Provide, as necessary, enclosures, heat tracing, heaters and sunshields, etc. to assure normal operations under these conditions.
7. Corrosive Areas: Provide instrument enclosures and hardware suitable for the corrosive location.
8. Hazardous Areas: All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Contract Drawings for the locations. All Work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all Owner costs arising there from.

H. Power Supplies.
1. Provide electrical instruments and control devices for operation on 120 VAC, 60 Hz current. Protect each device power supply with properly sized fuses.
2. Unless otherwise indicated provide battery backed up Uninterruptable Power Supply (UPS) with AC inversion for each control panel and PLC. UPS shall be sized to run the peak tributary load for a period of not less than 30 minutes. UPS shall be mounted in the respective panel. Minimum UPS size shall be 990 watt-hour. Provide bypass switch for panels to run directly from power source or through UPS with front of panel mounted indicator light showing current models.
3. Output overvoltage and overcurrent protective devices shall be provided for DC power supplies to protect instruments from damage due to power supply failure and to power supply from damage due to external failure. Power supplies shall be provided with NEMA 1 enclosures. Power supplies shall be mounted such that dissipated heat does not adversely affect other components. Source of operating power shall be 120 VAC, 60 Hz commercial power. Units shall be mounted within

the control panels. Power supply fusing shall be provided with blown fuse indicators.

I. Signal Isolators, Converters and Conditioners.

1. Insure that input-output signals of all instruments and control devices (new and existing) are compatible. Analog signals between field and panels shall be 4-20 mA unless specifically accepted otherwise. Granting such acceptance does not relieve the Contractor from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application, as required for accurate signal acquisition.

J. Auxiliary Contacts by Others.

1. Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

K. Painting.

1. Provide factory paint for instruments and equipment except where in pipelines. Provide paint as required in Section 09900 – Painting and Protective Coatings, for non-stainless steel structural supports, brackets, etc.

L. Electrical.

1. Work shall include the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required and not specifically included under Division 16.
2. Wiring installations shall include cables, conductors, terminals, connectors, wire markers, conduits, conduit fittings, supports, hardware and all other required materials not specifically included in the Work of other Divisions.
3. Provide the materials and complete the required installations for equipment grounding as specified in Division 16 of these Specifications and indicated on the Contract Drawings.
4. Incidental items not specifically included in the Contract Documents that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided and installed by the Contractor at no additional cost to the Owner.
5. Field Wiring. For wiring materials, refer to Division 16 and Details on the Contract Drawings. Test signal wiring for continuity prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type heat shrink label or equal for each termination.

M. Process Connections.

1. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance, etc. All instrument pneumatic tubing shall be Type 316 stainless steel. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shut down of

the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under other Divisions of these Specifications but coordinated by Division 13.

N. Electrical Transient Protection.

1. Instrument and control equipment mounted outside of protective structures (field mounted equipment) shall be equipped with surge-arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Both power and signal circuits shall be protected with surge and transient protectors installed at the source and destination ends of the circuits. Protective devices used on 120 VAC inputs to field mounted equipment shall be secondary surge protectors conforming to the requirements of IEEE C62.41 8/20µs wave form.
2. Surge and transient protectors shall be normally connected to the electrical system ground. When an electrical system ground is not available near the device, the protectors shall be connected to a ground rod located within 10 feet of the device. The ground rod shall meet all the requirements of Section 16060 - Grounding and Bonding, in Division 16, Electrical.
3. Protectors for analog signal circuits on or near field instrument housings shall be Innovative Technology Model OEM D22TX, Phoenix Contact Surge Trab Series, or accepted equal.
4. Protectors shall be provided for conductors penetrating panel enclosures for power circuits protectors shall be Innovative Technology Model HS-P-5P secondary arrestor, Phoenix Contact PT Series, or accepted equal. For analog and data circuits protectors shall be rail mounted Innovative Technology Model HS, or accepted equal. Protectors for data utilizing coaxial connections shall be Innovative Technology, or accepted equal. Provide multi-stage gas tube and solid state Innovative Technology, or accepted equal, protectors for digital circuits.

O. Spares and Maintenance Materials.

1. Furnish the following items as specified herein. Deliver to Engineer, as directed, with itemized list in a letter of transmittal accompanying each shipment.
2. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.
3. One Fuse of each size and type for every five used but no less than five of each type.
4. One Relay of each type for every five used but no less than two of each type.
5. One Panel Indicating Light Bulb for every five used but no less than four of each type.
6. One Transient Protector for every five used but no less than four of each type.

PART 3 - **EXECUTION**

3.01 PRODUCT HANDLING

A. Shipping Precautions: After completion of shop assembly, factory test, and acceptance, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. Special Instructions: Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment before packaging and shipment.

C. Tagging: Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the ICM system. Identification shall be prominently displayed on the outside of the package.

D. Storage: Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor at no additional cost to the Owner. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. Such tests shall be at no additional cost to the Owner, and if the equipment fails the tests, it shall be replaced at no additional cost to the Owner.

E. Protection during Construction: Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters.

F. Paint Finish: Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer, in conformance with the requirements of Section 09900 – Painting and Protective Coatings.

3.02 MANUFACTURER'S SERVICES

A. Furnish the following Manufacturer's services for all instrumentation provided:
   1. Perform bench calibration.
   2. Oversee installation.

3. Verify installation of installed instrument.
4. Certify installation and reconfirm Manufacturer's accuracy statement.
5. Oversee loop testing, prepare loop validation sheets, and certify loop testing.
6. Oversee pre-commissioning, prepare pre-commissioning validation sheets, and certify pre-commissioning.
7. Train the Owner's personnel.

3.03 INSTALLATION

A. General:
   1. All instrumentation, including instrumentation furnished under other Divisions, shall be installed per the manufacturers' instructions and Division 13.
   2. Equipment Locations: The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment that do not impact material quantities or cause material rework, make such changes without additional cost to the Owner.

B. Conduit, Cables, and Field Wiring
   1. All conduit shall be provided, in accordance with Section 16111 – Conduit.
   2. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, remote I/O, PLC I/O, and other non-specialty field wiring and cables shall be provided and installed, in accordance with Section 16120 – Wire and Cable (600V).
   3. All ICM system specialty cables, data highway fiber optic cable and specialty cable termination devices shall be provided under Division 13 and installed, in accordance with Section 16120 – Conductors and Cables.
   4. All field cables and wiring terminations and wire identification at ICM system equipment furnished under this or any other Division shall be provided in accordance with the requirements of Section 16120 – Conductors and Cables. All terminations shall be checked by the equipment supplier and the electrical contractor.

C. Instrumentation Tie-Downs: All instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements that apply to the site.

D. Existing Instrumentation: Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned and recalibrated by an authorized service facility of the instrument Manufacturer. Provide certification of this Work before reinstallation of each instrument. Provide replacement for interim period as required.

E. Ancillary Devices: The Contract Documents show all necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments

and specific installation requirements at no additional cost to the Owner. All such additions and all such changes, including the proposed method of installation, shall be submitted to the Engineer for acceptance before commencing the Work. Such changes shall not be a basis of claims for extra work or delay.

F. Installation Criteria and Validation: All field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on installation requirements of the Contract Documents.
2. Technical assistance is available to installation personnel at least by telephone.
3. Installation personnel have at least one copy of the accepted and approved shop drawings and data.
4. Instrument process sensing lines shall be installed similar to conduit specified under Section 16050 - Basic Electrical Materials and Methods. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3-feet of rigid tubing.
5. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.
6. All differential pressure elements shall have three valve manifolds.
7. All flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
8. All power and signal wires shall be terminated with crimped type lugs.
9. All connectors shall be, as a minimum, water tight.
10. All wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
11. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically accepted by the Engineer. All wiring shall be protected from sharp edges and corners.
12. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.
13. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. Certify in writing that for each loop or system checked out, all discrepancies have been corrected.
14. The Owner will not be responsible for any additional cost of rework attributable to actions of the Contractor or the CSI.

3.04 CALIBRATION

A. General: All devices provided under the instrumentation Sections shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Calibration Points: Each instrument shall be calibrated at 20, 40, 60, 80 and 100% of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Testing Standards.

C. Bench Calibration: Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Field Calibration: Instruments that were not bench-calibrated shall be calibrated in the field to insure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. All samples and sample gases shall be furnished by the manufacturers.

F. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. Have the Instrumentation Supplier sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.05 LOOP TESTING

A. General: Individual instrument loop diagrams per ISA Standard S5.4 - Instrument Loop Diagrams, expanded format, shall be submitted to the Engineer for review before the loop tests. The Contractor shall notify the Engineer of scheduled tests a minimum of 30 days before the estimated completion date of installation and wiring of the ICM. After the Engineer’s review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the Engineer.

B. Control Valve Tests: All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to ensure that no changes have occurred since the bench calibration.

C. Interlocks: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.

D. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance its Manufacturer's specifications and instructions. Any instrument that fails to meet any Contract requirement, or, in the absence of a Contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the direction of the Engineer at no additional cost to the Owner.

E. Loop Validation: Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA and PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Specified accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks that incorporate analog elements, simulated sensor inputs corresponding to 20, 40, 60, 80 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated root-mean-square-summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. All analog loop test data shall be recorded on test that include calculated root-mean-square-summation system accuracy tolerance requirements for each output.

F. Loop Validation Sheets: Prepare loop confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop provided by the CSI:

1. Project name.
2. Loop number.
3. Tag number, description, manufacturer and model number for each element.
4. Installation bulletin number.
5. Specification sheet number.
6. Loop description number
7. Adjustment check.
8. Space for comments.
9. Space for loop sign-off by Instrumentation Supplier and date.
10. Space for Engineer witness signature and date.

G. Loop Certifications: When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the Engineer as a witness, with test data entered, shall be submitted to the Engineer together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

3.06 PRE-COMMISSIONING

A. General: Pre-commissioning shall start after acceptance of all wire test, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control

system complies with all Contract requirements. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

B. Pre-commissioning Procedures and Documentation: All pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer as submitted by the CSI. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, that include calculated tolerance limits for each step. Completion of all system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.

C. Operational Validation: Where feasible, system pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

D. Loop Tuning: All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 20, 40, 60, 80 and 100% of span and the results checked against indicated accuracy tolerances.

E. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on one of two types of test forms as follows:
   1. For functions that can be demonstrated on a loop-by-loop basis, the form shall include:
      a. Project name.
      b. Loop number.
      c. Loop description.

d. Tag number, description, manufacturer and data sheet number for each component.

e. Space for sign-off and date by both the CSI and the Engineer.

2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description, the following information shall be included:

a. Specification page and paragraph of function demonstrated.

b. Description of function.

c. Space for sign-off and date by both the CSI and the Engineer.

F. Pre-commissioning Certification: Submit an ICM system pre-commissioning completion report that shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

3.07 ONSITE SUPERVISION

A. Furnish the services of an on-site service engineer to supervise and coordinate installation, adjustment, testing, and start-up of the ICM system. The Engineer will be present during the total period required to affect a complete operating system. A qualified team of the Instrumentation Subcontractor personnel shall be on site as required to check all equipment, perform the tests indicated in this Section, and furnish startup services.

3.08 PERFORMANCE TEST

A. The entire ICM system shall operate for 30 days without failure.

B. Furnish all necessary support staff as required to maintain the system and to satisfy the repair or replacement requirements.

C. If any component fails during the performance test, it shall be repaired or replaced within 4 hours and the ICM system shall be restarted. If the system is not repaired and running within four (4) hours or more than six component failures within the four (4) hour repair period, the system shall be restarted and operate for an additional 30 days without failure.

3.09 TRAINING

A. Test entire ECM system in accordance with the requirements of Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements.

B. General: Train the Owner's personnel on the maintenance, calibration and repair of all instruments provided under this Contract.

C. Instructions: The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

D. Duration: Each training class shall be a minimum of 8 hours in duration and shall cover, as a minimum, operational theory, maintenance, troubleshooting/repair, and calibration of instruments. Include a minimum of 4 hours training per instrument or control device; for PLC, and software include 8 hours for each type supplied.

E. Schedule: Training shall be performed during the pre-commissioning phase of the project and 30 days after acceptance. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The Owner and Engineer will review the course outline and the training manual as submitted by the CSI for suitability and provide comments that shall be incorporated.

F. Agenda: The training shall include operation and maintenance procedures, trouble shooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment.

G. Documentation: Within 10 days after the completion of each session the Contractor shall submit the following:
   1. List of all Owner personnel who attended the session.
   2. Evaluation of Owner personnel via written testing or equivalent evaluation.
   3. Copy of the training materials used including all notes, diagrams, and comments.

3.10 ACCEPTANCE

A. For the purpose of this Section, the following conditions shall be fulfilled before the Work is considered substantially complete:
   1. All submittals have been completed and accepted.
   2. The ICM system has been calibrated, loop tested and pre-commissioned.
   3. The Owner training has been performed.
   4. All required spare parts and expendable supplies and test equipment have been delivered to the Owner.
   5. The performance test has been successfully completed.
   6. All punch-list items have been corrected.
   7. All record drawings in both hard copy and electronic format have been submitted.
   8. Revisions to the operations and maintenance manuals information that may have resulted from the field tests have been made and reviewed.
   9. All debris associated with installation of instrumentation has been removed.
   10. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

3.11 WARRANTY

A. Supplier shall warrant design, materials, and workmanship for customary period applicable for the equipment involved, but in no case for less than 24 months from date of acceptance, in accordance with the requirements of Paragraph 1.03, J, 1.

B. During warranty period, if mechanical defects occur, or equipment fails to perform in accordance with specified performance requirements under conditions of normal use within the design limitations of the equipment, supplier shall, upon request of the company, repair or replace equipment or parts as required and shall place equipment in proper working condition, assuming all expenses involved.

C. A written prepaid maintenance contract executed by the CSI shall be provided to the Owner for on-site warranty and travel maintenance services, in accordance with the requirements of Paragraph 1.03, H, and Paragraph I, 1. This maintenance contract shall include all travel and living expenses, labor, parts, and emergency calls providing on-site response within 4 hours, to provide complete system maintenance for a period of one year after the date of final acceptance of the system.

D. The maintenance contract shall include a minimum of 4 (quarterly) preventive maintenance visits by a qualified serviceman of the Supplier who is familiar with the type of equipment and software provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of system equipment and written verification of calibration and correct software operation.

E. An annual fee shall be quoted 90 days before completion of the first year maintenance contract for annual maintenance subsequent to the first year of operation. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from day of issue.

END OF SECTION

SECTION 13200

INSTRUMENTATION, CONTROL AND MONITORING SYSTEM PANELS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements specified in Division 1 of these Specifications form a part of this Section. Panel(s) shall be fabricated, instruments installed, and wired in the manufacturer's factory. Wiring shall be completed and tested prior to shipment. External connections shall be by way of numbered terminal blocks.

B. Contractor shall receive, set, and connect system panels furnished by others.

C. Where required Contractor shall rework existing control panel(s) to add or eliminate functionality as shown on the Contract Documents.

D. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 09900 – Painting and Protective Coatings.
   3. Section 13000 – Instrumentation, Control and Monitoring System General Requirements.
   4. Section 13300 – Instrumentation, Control and Monitoring System Components.
   5. Section 13400 – Instrumentation, Operator Workstations, Human Machine Interface Terminals, and Programmable Logic Controllers.
   6. Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements.
   7. Section 16120 – Wire and Cable (600V).
   8. Section 16473 – Low Voltage Surge Protection Devices.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. Instrument Society of America (ISA).
      a. ISA S20 – Specification Forms for Process Measurement.
      b. ISA RP60.6 – Nameplates, Labels and Tags for Control Centers.
      c. ISA S18 – Standard Basis or Alarm Management.
   2. Institute of Electrical and Electronics Engineers (IEEE).
      a. IEEE C62.41 – Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less).
      b. IEEE 472 – Power Surge Requirements.

3. American Society for Testing and Materials (ASTM).
   a. ASTM A36 – Specification for Carbon Structural Steel.
4. National Electrical Manufacturers Association (NEMA).
   a. NEMA ICS – Magnetic Motor Starter.
   b. NEMA – Electrical Codes.
5. Factory Mutual (FM).
6. Underwriters Laboratories Inc. (UL).

1.03 SUBMITTALS

A. Shop drawings shall be submitted in accordance with Section 01300 – Submittals, and Section 13000 – Instrumentation, Control and Monitoring System General Requirements.

B. Control Panel Engineering Submittal: The Contractor shall submit a control panel engineering submittal for each control panel and enclosure provided and/or existing control panel to be reworked. The submittal shall completely define and document the construction, finish, layout, power circuits, signal and safety grounding circuits, fuses, circuit breakers, signal circuits, internally mounted instrumentation and SCADA system components, face plate mounted instrumentation components, internal panel arrangements, and external panel arrangements. All panel drawings shall be "B" size, and all data sheets and manufacturer specification sheets shall be "A" size. The submittal shall be in conformance with NEMA Standard ICS-1-1.01, shall be submitted as a singular complete bound volume or multi-volume package and shall have the following content:

1. A complete index shall appear in the front of each bound volume. Panels shall be indexed by system or process area, and drawings and data associated with a panel shall be grouped together. All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.
2. Scale construction drawings which define and quantify the type and gauge of steel to be used for panel fabrication, the ASTM A36 grade proposed for structural shapes and straps, panel door locks and hinge mechanisms, type of bolts and bolt locations for section joining and anchoring, details and proposed locations on the use of "Unistrut" members, stiffener materials and locations, electrical terminal box and outlet locations, electrical access locations, print pocket locations, writing board locations and lifting lug material and locations.
3. Scale physical arrangement drawings which define and quantify the physical groupings comprising control panel sections, auxiliary panels, subpanels, and racks. Cutout locations with nameplate identifications shall be indicated.
4. Front of panel layouts for all control panels.
5. Schematic/elementary diagrams depicting all control devices and circuits and their functions.
6. Wiring/connection diagrams locating and identifying electrical devices (including tag number), terminals and interconnecting wiring. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.

7. Interconnection diagrams locating and identifying all external connections between the control panel/control panel devices and associated equipment. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points. The tag number shall be included with all interconnection descriptions.
8. Control sequence diagrams to portray the contact positions or connections required to be made for each successive step of the control action. Written descriptions explaining the control sequence diagrams and system operation shall be furnished.
9. Completed ISA-S20 data sheets for all instrumentation devices associated with each control panel, supplemented with manufacturer specification sheets which verify conformance to the requirements of the Contract Documents.
10. A bill of material which enumerates all devices associated with the control panel.
11. A priced listing of spare parts in conformance with Section 13000 – Instrumentation, Control and Monitoring System General Requirements.

1.04 SPARE PARTS AND SPECIAL TOOLS

A. Control panel spare parts and special tools shall be provided in accordance with Section 13000 – Instrumentation, Control and Monitoring System General Requirements. Additional manufacturer recommended spare parts or special tools required for normal operation and/or maintenance of the components supplied with the control panels shall be included.

B. All spare parts and special tools shall be submitted before startup commences, and delivered suitably wrapped and identified prior to equipment final acceptance.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Furnish, fabricate, test, and make ready for operation the control panels and cabinets required to complete the Instrumentation and Controls design per the Contract Specifications including Contract Specification 13000 “Instrumentation and Controls – General Provisions” and as shown on the Contract Drawings.

B. Unless otherwise specified on the Contract Drawings, all control panels and cabinets shall be of the fully enclosed type suitable for the mounting of the instrumentation and control devices as listed in the Contract Documents and as shown on the Contract Drawings.

C. All control panel and cabinets shall be fully lockable with a lock installed in the door handle or by padlocking using a hasp and staple for padlocking. Locks for each panel or cabinet provided under this Contract shall be keyed alike.

D. All panel components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other

component. Components mounted on the inside of panels shall be mounted on removable plates, in such a manner that the component may be removed without removing the plate, and shall not be directly mounted to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Mounting orientation shall be in accordance with the requirements of each component.

E. Front of panel devices (indicating lights, pushbuttons, selector switches, etc.) shall be grouped together by associated equipment/function. Layout of the control devices shall be in accordance with the sequence of operations proceeding from left to right across the front of the control panel.

F. The instruments designated for rear-of-panel mounting shall be arranged within the panel in a manner to allow for ease of maintenance and adjustment.

G. Instruments to be mounted inside panels that require rear access for wiring, calibration, or testing and that cannot be surface mounted on interior back plates while still providing access to all wiring (even if pre-wired to external terminal strips), calibration or testing functions shall be mounted on swing-out sub-panels to facilitate such maintenance, troubleshooting, or testing activities without requiring one to physically stand inside the panel.

H. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.

I. Front of panel instruments that are more than 6-inches deep, weight more than 10 pounds, or exert more than 4 ft-lb moment force on the face of the panel shall be supported underneath by at least 1-inch x 1/8-inch thick steel angle to prevent wrapping or damage to the panel and/or instrument. Front of panel instruments shall be designed to be flush or semi-flush mounted.

J. Conductors running from the field to the panels shall be continuous without splices, except at Engineer reviewed and accepted junction boxes. The junction boxes shall have terminal blocks with at least 20 percent spare terminals. Special care shall be exercised to pass all grounding and shield conductors through such junction boxes with the least possible resistance. Conduit and cables entering panels shall be sealed to prevent the intrusion of gases or moisture.

K. The internal framework of each panel shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging and lifting of the control panels during installation. Plugs shall be provided and shall unobtrusively fill the panel lifting ring holes when substituted for the lifting rings after installation is complete. The control panel framework and instrument supports associated with each Control Panels shall be designed in accordance with the Seismic Zone as noted on structural notes of the Contract Drawings.

L. Where applicable, also provide a nameplate, which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Engraving

shall be approximately 3/16-inch in height, consisting of black lettering on a high visibility yellow background. Nameplates shall be beveled and attached to panels by self-tapping stainless-steel screws or No. 10/32 Type 304 stainless-steel machine screws with nuts and flat and lock washers. Adhesive bonded or glued on nameplates shall not be accepted.

M. Provide control panels as indicated on Contract Drawings. Refer to Sections 13000: Instrumentation, Control and Monitoring System General Requirements; 13300 - Instrumentation, Control, and Monitoring System Components; 13400 - Instrumentation, Operator Workstations, Human Machine Interface Terminals, and Programmable Logic Controllers for complete panel requirements.

N. Note: Motor Control Centers shall be tied in to the nearest SCADA control panels as shown on the drawings.

2.02 PANEL ACCESSORIES

A. Nameplates
   1. Engraved nameplates shall be provided for components mounted on or within panel(s). Nameplates for indoor panels shall be black lamicoid with minimum 1/4-inch high white letters for major area titles, 3/16-inch for component titles, and 5/32-inch for sub-titles and shall be fastened with by stainless steel screws. Nameplates for panels located outdoors shall be engraved stainless steel fastened by stainless steel screws.
   2. Panel face mounted nameplates shall have the entire ISA tag number of the component as well as the service description.
   3. Inside panel nameplates shall identify relays, timers, fuses, circuit breakers, terminal block assemblies, power supplies, signal conditioners, and other major components by the ISA tag identifier or component ID code. Nameplates shall be mounted near each device and shall be clearly visible.
   4. Each panel shall have a face mounted laminated nameplate with 1/2-inch letters designating the panel identification tag and service.

B. Power Supplies
   1. Power supplies shall be provided as required to power devices requiring DC power.
   2. Power supplies shall convert 120 VAC, 60-Hz power to DC power of the appropriate voltages(s) with sufficient voltage regulation and ripple control to assure that the instruments being supplied can operate within their required tolerances.
   3. Output overvoltage and overcurrent protection shall be provided with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from external failures.
   4. Power supplies shall be enclosed in NEMA 1 enclosures.

C. Relays

1. Relays shall be provided as necessary to perform switching functions required of control panels and other control circuits. Relays shall have screw terminal interface with the wiring. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.

   a. General Purpose Relays: This type shall be used for logic and switching power to external loads and shall be general purpose industrial types. They shall be of the dust cover enclosed plug-in type with 8 or 11 pins, screw terminal, octal sockets. Relays shall have up to 3 pole form C contracts rated for 10 amperes at 120 VAC and be equipped with neon indicator lamps. Relays shall be as manufactured by Potter-Brumfield, or equal.

   b. Signal Switching Relays: This type shall be used for switching analog signals of 4-20 mAdc or 1-5 VDC within panels. Units shall have double-throw dry bifurcated crossbar contacts in a break-before-make configuration rated for 15VA minimum. Signal switching relays shall be sealed to prevent entry of contamination in the form of dust, dirt, or moisture. A neon status-indicating light shall be provided with each relay.

D. Timers

1. Timer Delay Relays:

   a. Units shall be adjustable time delay relays with the number of contact arrangements as required. A LED status light shall be provided to indicate power on and relay status. Contacts shall be rated for 10 amperes at 120 VAC. Integral knob with calibrated scale shall be provided for adjustment time. Initial setting shall be as shown with time delay range approximately three times the initial setting.

   b. Time delay rangeability shall be at least 10:1. Operating voltage shall be 120 VAC, plus or minus 15 percent at 60Hz. Operating temperature shall be -4 degrees F to 140 degrees F. Repetition accuracy shall be plus or minus 0.5 percent. Timer will be Syrelec LR2U Series or accepted equal.

2. Recycle Timers:

   a. Recycle timers shall be of the motor driven adjustable type with dials and pre-settable pointers. The timers shall have cycle times as shown on the Drawings. The timers shall operate from 120 VAC, single-phase, 60 Hz power and shall be for surface mounting. Output contacts shall be double throw and rated for 10 amperes at 120 VAC. The number of contact sets shall be sufficient to perform the required control functions. Where more contacts are required than supplied as commercial standards, control relays of equal rating shall be used to supplement the timer contacts. When specified as instantaneous (INST), relay contacts shall be supplied as part of the timer and shall be operated by the timer control power independently of the timed contacts. Timers shall be of the

plug-in type and enclosed in dust-proof cases. Connection shall be by numbered screw terminals of the timer connector. The timers shall be as manufactured by Eagle Signal.

E. Signal Conditioning and Converters

1. Square Root Extractors: Square root extractors shall produce an output signal that is linearly proportional to the square of the input signal. Accuracy shall be +0.25% of span. Power input shall be 120 VAC, 60 Hz. Span and zero shall be adjustable. Square Root Extractors to be manufactured by AGM Electronics Model TA-4006, Moore Industries Model SRT, Phoenix Contact, or accepted equal.
2. Signal Adder - Subtractors: Signal adder/subtractors shall accept current input signals and produce a current output signal proportional to the sum or difference of the input signals. The input signals shall be conditioned within the unit to provide equally weighted inputs to the summing stage. The output shall remain algebraically correct upon loss of any input signal. Output span and zero shall be adjustable and accuracy shall be +0.5% of span. Units shall be surface or rack mounted. Input power shall be 120 VAC, 60 Hz. Signal Adder/Subtractors to be manufactured by Moore Industries Model ASM, AGM Electronics Model TA-4005, Phoenix Contact, or accepted equal.
3. Signal Inverter: Signal inverters shall have complete isolation of input, output and power input. Signal input shall be 4-20 mA into 50 ohms maximum. Signal output shall be 20-4 mA, linearly inverse to the input signal into 1000 ohms minimum. Power input shall be 120 VAC, 60 Hz. Span and zero shall be adjustable; accuracy shall be +0.1% of span. Units shall be surface or rack mounted. Signal Inverters to be manufactured by Moore Industries Model SCT, AGM Electronics Model TA-4000, Phoenix Contact, or accepted equal.
4. Signal Isolators/Signal Boosters: Signal inverters shall have complete isolation of input, output and power input. Signal input shall be 4-20 mA into 50 ohms maximum. Signal output shall be 4-20 mA, direct linearly proportion to the input signal into 1000 ohms minimum. Power input shall be 120 VAC, 60 Hz. Span and zero shall be adjustable; accuracy shall be +0.1% of span. Units shall be surface or rack mounted. Signal isolator/Boosters to be manufactured by Moore Industries Model SCT, AGM Electronics Model TA-4000, Phoenix Contact, or accepted equal.
5. Pulse Rate to Voltage/Current Signal Converter: The signal converters shall accept a pulse rate input signal and produce a voltage or current output signal in linear proportion to the input signal. The output span and zero shall be adjustable and accuracy shall be within +0.1% of span. The unit shall be surface or rack mounted. Power input shall be 120 VAC, 60 Hz. Pulse Signal Converters to be manufactured by Moore Industries Model FDT, AGM Electronics Model TA-5100, Phoenix Contact, or accepted equal.
6. Resistance/Current Signal Converter: The signal converters shall accept potentiometer signals and produce a voltage or current signal output in linear proportion to the input signal. Output span and zero shall be adjustable and accuracy shall be ±0.1% of span. The unit shall be surface or rack mounted. Power input shall be 120 VAC, 60 Hz. Resistance/Current Signal Converters to be manufactured

by Moore Industries Model PTT, AGM Electronics Model TA-4003, Phoenix Contact, or accepted equal.

F. Front of Panel Devices

1. Digital process indicators: The indicator shall be self-contained instruments that display process signals directly in engineering units. Units shall be suitable for panel mounting and shall use a 3-1/2 digit LED display of no less than 0.5-inch height. The input signal to the digital process indicator shall be 4-20 mA DC or 1-5 VDC. The input sample rate of the unit shall be a minimum of 2 per second. The unit shall have an auto-zeroing feature and shall have provisions for field adjustable scaling [and][or] offset. Accuracy shall be +1 least significant digit. Input power to the digital indicator shall be 120 VAC, 60 Hz. Digital process indicators to be manufactured by Newport Infinity Model, Action Instruments Co. or accepted equal.
2. Electro-Mechanical Totalizers: Electro-mechanical totalizers shall be front panel mounting units with a minimum of seven non-resettable digits. Totalizers shall be approximately 2-inch high by 2-inch wide by 2-inch deep. Minimum character height shall be 0.150-inch. Electro-mechanical totalized to be manufactured by Durant Series 7-Y, Kessler-Ellis Type MK, or accepted equal.
3. Totalizers, LCD: LCD totalizers shall be electronic type with a minimum of seven non-resettable digits. Counters shall be approximately 1-1/2-inch high by 2-inch wide by 3-inch deep and shall be suitable for front panel mounting. Minimum character height shall be 0.2 inches. Each electronic counter shall be battery-powered with a minimum 10-year battery replacement requirement. LCD Totalizers shall be manufactured by Veeder-Root Model 799808 or accepted equal.
4. Selector, Wateright, NEMA 4x: Units shall be heavy duty, watertight, industrial type selector switches with contacts rated for 120V ac service at 10 amperes continuous. The switches shall be rated for NEMA 4X watertight, corrosion resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have standard size, black field, legend plates with white markings. Operators shall be black knob type. Units shall have the number of positions and contact arrangements shown. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or accepted equal.
5. Pushbutton, Momentary, Watertight, NEMA 4X: Units shall be heavy duty, watertight/oiltight, industrial type pushbuttons with momentary contacts rated for 120VAC service at 10 amperes continuous. The pushbuttons shall be rated for NEMA 4X watertight, corrosion-resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have standard size, legend plates with black field and white markings. Button color shall be as required. Units shall have the contact arrangements as required. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or accepted equal.

6. Indicating Lights, Watertight, NEMA 4X: Units shall be heavy duty, watertight, push-to-test, industrial type with integral transformer for 120VAC applications, and full voltage type for 24VDC applications. The lights shall be rated for NEMA 4X watertight, corrosion resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have factory engraved standard size, black field, legend plates with white markings. Units shall have screwed on prismatic lenses in colors as shown. When a common lamp test function is specified, the push-to-test feature will not be required. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or accepted equal

G. Corrosion Inhibitors
   1. Panels shall be provided with corrosion inhibiting devices to prevent corrosion of internal equipment. The corrosion inhibitors shall be of the VCI emitter type as manufactured by Cortec Corp., Hoffman Engineering, or accepted equal.
   2. Provide a two-year supply of inhibitors for each panel furnished.

2.03 PANEL ELECTRICAL

A. Circuit Schematics
   1. Circuit schematics when shown are for reference only. The Contractor may elect to perform the required functions by other standard logic techniques. Components and circuits used shall be subject to review and acceptance by the Engineer. Switching circuits shall be checked and verified for specified performance by testing before shipment. Non-conforming circuits shall be corrected and retested.
   2. Where reference is made to packaged mechanical equipment controls in the schematics or specifications, the interface with Instrumentation specified control panels may vary from the referenced circuit because the panels are supplied as the Manufacturer's standard. The Contractor shall adapt the indicated schematic as necessary to provide the indicated functions, limited only by the provided access to the internal circuits of the control panels via terminal strips. He shall not modify the panels without Supplier's approval.
   3. Relays, timers, etc., referenced in the contract documents are intended to show function. Additional relays may be required in conjunction with the items shown to provide the total number of contacts required. Where limit, pressure, float switches, etc. are used, and more than SPDT contacts are indicated by the schematics, additional contacts required shall be furnished by using auxiliary relays. Control and pilot devices such as relays, timers, etc. shall have 120 VAC, 10 amp rated contacts except where noted with coil voltage as required. One N.O. spare contact shall be provided on each relay.
   4. Control device contacts going to unit substations and high voltage equipment for motor control shall be rated 240 VAC/125 VDC at 10 amps. The contacts shall handle 50 Amps inrush on "make" at 120 VAC and one amp on "break" at 125 VDC.

B. Power Distribution
   1. Power Source:
      a. Each panel shall be provided with one or more 120 VAC, 60-Hz feeder circuits from an associated circuit breaker in a power distribution panel provided under Division 16 Electrical. Each panel shall be provided with a feeder circuit conduit entry and separate terminal blocks for termination of the wires.
   2. Internal Circuit Power Distribution:
      a. A power distribution box with cover shall be provided within each panel with a main feed circuit breaker. Additional branch breakers shall be added as required.
      b. No more than 20 devices shall be feed from any one branch breaker.

C. Transient Protection for Instruments and Equipment.
   1. General:
      a. Provide transient protection devices to protect field instruments and equipment from the effects of transient surges caused by lightning and other electrical sources. TVSS shall be provided for AC power source, signal, control, communication and data lines.
      b. Provide protection for all field and panel mounted instruments and equipment that have portions of interconnecting wiring located outside of protected buildings.
      c. Transient protection devices shall be suitable for IEEE C62.41 category C locations.
      d. Transient protection devices shall be integral to instruments and equipment, otherwise as described below.
      e. Provide transient protection devices at instruments and equipment as follows:
         i. On 480V 3ph power connection in control panels.
         ii. On 120 VAC power connection.
         iii. On analog signal connection through surge protected terminal blocks, as well as at the instrument.
         iv. On discrete signal connection through surge protected terminal blocks.
         v. On digital communication signals.
         vi. On other types of electrical connections.
      f. Coordinate transient protection devices with instrument and equipment manufacturer.
      g. Connect and ground in accordance with transient protection device manufacturers instructions.
      h. Transient protection devices installed within panels and located at field instruments, in conformance with the requirements of Section 16473 – Low Voltage Surge Protection Devices, shall be by the same manufacturer.
      i. Installation: As per the appropriate standard details and as per manufacturer's instructions.

D. Control Voltages

1. When the control voltage is not specified in the schematics the Contractor may elect to use the 120 VAC power source. A separate low voltage circuit for the indicating lamps or individual transformers with lamps shall be provided for all panels. Lamp voltage shall not exceed 28VAC or DC.
2. Defeatable safety interlock switches shall be provided on access doors to disconnect local and foreign voltages only if required by safety codes of applicable regulating authorities.

E. Internal Panel Wiring

1. Internal panel wiring shall be 300 volt 19 strand No. 16 AWG, 90oC MTW, Class C or THHN/THWN approved as 90oC MTW. Panel wiring not run in wireducts shall be bundled and tied. Wiring for signal circuits shall be twisted not smaller than No. 18 AWG, and be separated at least 6-inches from any power wiring.
2. Wires to internal components shall be connected to the "inside" of the terminal strip. Wires to external components shall be connected to the "outside" of the terminal strip. No more than two wires shall be connected to any one terminal point.
3. Where panel components are provided for use as "spare" equipment, wiring from the components to the panel terminal blocks shall be provided.
4. Intrinsically safe wiring in enclosures shall be separated by at least 2-inches and secured to prevent inadvertent contact. Wiring ducts may be used provided they maintain a 3/4-inch separation between intrinsically safe and non-intrinsically safe wiring.

F. Service Receptacles and Lights

1. Panels shall be internally lighted by minimum 12-watt LED lamps, provided with guards and shall automatically illuminate when the panel door is opened. One light shall be provided for every 4-feet of panel width.
2. Each panel shall be provided with 15 amp ground fault protected, duplex service outlets. One outlet shall be provided for every 4-feet of panel width and mounted to the panel sub plates.
3. The lights and receptacles shall be wired to separate outgoing terminal blocks for 120 VAC, 60-hertz, single phase supply.

G. Wire Markers and Color Coding

1. Wire markers shall be provided at each wire termination point. Wire tags shall be slip-on or snap-on PVC wire markers with legible machine printed markings and numbers. Adhesive or taped on tags will not be accepted.
2. Wiring terminating at terminal blocks shall have wire markers. Terminal blocks shall be numbered in numerical order.
3. Control wiring associated with 120 VAC control circuits which are de-energized when the main disconnect is opened shall be color coded "red."

4. Control wiring associated with control circuits which remain "hot" when the main disconnect is open shall be color coded "yellow." Yellow wiring leaving the panel shall be brought to an isolated set of terminal blocks.
5. DC Control wiring shall be color coded "Blue" (+); Blue with white tracer (-).
6. Ground wires shall be color coded "Green."
7. Intrinsically safe wiring shall be light blue. Terminal blocks and cable ducts associated with intrinsically safe wiring shall also be light blue.

H. Wire Duct

1. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of one-inch wide and 3-inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of non-metallic materials with a voltage insulation in excess of the maximum voltage carried therein.
2. Wiring duct shall not be filled to more than 60% visible fill.

I. Terminals Blocks

1. 600-volt terminal blocks shall be provided for termination of circuits entering or leaving panels. Terminal blocks shall have screw clamp compression, dead front barriers with current bar providing direct contact with wire between the compression screw and yoke. Yoke, current bar, and clamping screw shall be constructed of high strength and high conductivity metal. Yoke assembly shall guide strands of wire into the terminal. Current bar shall provide dependable vibration-proof connections. Terminals shall be constructed to allow connection of wires without any special preparation other than stripping. Individual terminals shall be rail mounted to create a complete assembly such that jumpers can be installed with no loss of space on terminal or rail.
2. Terminal block components shall be sized to allow insertion of all necessary wire sizes and types. Terminal blocks shall be provided with field-marked tags.
3. Sufficient terminal blocks shall be provided to terminate wires routed to the panel, all spare annunciator points and spare conductors.
4. Connections for future functions shall be wired to numbered terminal blocks, grouped separate from the terminal blocks in use. Terminal blocks shall be grouped to keep 120 VAC circuits separate from the 24 VDC circuits.
5. Terminal blocks shall be CSA certified and UL approved. Control type terminal blocks shall be as manufactured by Phoenix type UK10, Weidmuller or equal. Analog signal type shall be knife type disconnect Phoenix type UK5-MTK-P/P, Weidmuller or equal. Shields shall be terminated on Phoenix type USLKG4, Weidmuller or accepted equal.

J. Intrinsic Safety (IS) Barriers

1. Intrinsically safe barriers shall be provided in control panels when connecting instruments in hazardous areas to control system in safe area. IS barriers shall prevent instruments and low voltage circuits in hazardous areas from releasing

sufficient energy to ignite volatile gas. IS barriers shall be suitable for DIN rail mounting and shall be FM and UL approved.

2. Manufacturers: STAHL, MTL, Crouse-Hinds or accepted equal.

2.04 HEATING AND VENTILATION

A. Panels shall permit continuous operation of all components with ambient temperatures of up to 105 degrees F.

B. Panels shall be provided with louvers and/or forced ventilation as required to prevent temperature buildup. Except for panels with their backs directly adjacent to a wall, louvers shall be in the rear of the panels, top and bottom, and shall be stamped sheet metal construction. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides. Forced air ventilation fans, where used, shall be provided with washable or replaceable filters. Fan motors shall operate on 120 VAC, 60-Hz power.

C. When required, space heaters shall be provided to raise interior temperatures to 45^{o}F whenever ambient temperatures fall below 32^{o}F Space heaters and thermostats shall be rated for 120V ac and shall be wired to terminal blocks to facilitate the connection of an external power source.

D. Should sufficient heat be generated within a panel where dissipation cannot be adequately accomplished with natural convection or forced air ventilation, a heat exchanger or air conditioner shall be provided. Air conditioners that require cooling water supply shall only be provided where accepted by Engineer. Pneumatic panel coolers shall only be supplied where sufficient excess instrument quality air is available and only then when accepted by Engineer.

E. Control panels that are exposed to sunlight shall be equipped with adequate sunshields. The sunshield shall consist of one or more pieces of stainless steel, FRP, or other suitable material of sufficient size to cover the top, sides, and rear of the panel (where applicable), and to hang over the front of the panel to shade any instruments mounted there. Sunshield pieces shall be secured to the panel by bolts and shall have no less than 1 inch of clearance from the panel and from one another, to allow for air circulation over the sunshield surfaces and access to panel door(s).

2.05 PIPING AND WIRING

A. Piping, in conformance with the requirements of Section 15060 – Piping and Appurtenances, and wiring, in conformance with the requirements of Section 16120 – Wire and Cable (600V), within each panel shall be done in a good workmanlike manner, grouped, and rigidly supported to give a neat appearance. Control components not flush mounted on the front of the panel shall be mounted on fully accessible subpanels or racks within the panels for easy removal. Signal lines leaving the panels shall terminate at bulkhead fittings or terminal blocks and shall be tagged to facilitate field connections.

2.06 SIZE AND SUPPORTS

A. Panels shall be of sufficient size to adequately enclose indicated instruments plus ample interior clearance to allow for installation, general servicing, and maintenance of the instruments. Weight of instruments shall be supported by channel supports.

2.07 MOUNTING

A. Methods for securing panels shall be detailed on panel fabrication drawing submittals.

2.08 FRONT OF PANEL COMPONENT ARRANGEMENTS

A. The instruments and controls to be located on each panel will be shown on the instrumentation drawings, electrical schematics, and/or in the individual specification. Cut out for devices shall be made using manufacturer's supplied templates and instructions.

B. Where so indicated, the instruments mounted in the panels shall have the nominal size and general arrangement shown. Panel layouts and nameplates shall conform to the accepted submittal.

C. Panel face mounted equipment shall consist of pilot-lights, pushbuttons, selector switches, meters, indicating timers, analyzers and name tags. Spacing between horizontal rows of components shall be 1 1/2-inches center to center minimum; spacing between vertical columns of components shall be 1 7/8-inches center to center minimum.

D. The distance from the bottom row of components to the floor shall be not less than 36-inches. The top row of recording and indicating instruments shall be centered approximately 60-inches above the floor. The maximum height for annunciator windows shall be 85-inches above the floor. In general, indicating lights, pushbuttons, indicators and hand switches shall be mounted in accordance with the sequence of operation from left to right and top to bottom.

E. Filler pieces, bolt on plates, and caps to cover unused holes on panel front shall not be used. Unused holes in panel will not be acceptable. Trim plates or brackets supplied with front of panel devices may be used as instructed by the device manufacturer, to fill gaps around a device cut out.

2.09 REAR OF PANEL COMPONENT ARRANGEMENTS

A. Equipment installed on each panel subplate, shall be provided with a minimum spacing between the component and the wireduct of 1 1/2-inches above and 1-inch below. Minimum spacing between adjacent components shall be 1/4-inch.

B. A minimum of 2-inches shall be provided between terminal strips and wireducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on the vertical edges of the subplate.

C. Subplates shall have a minimum of 25% spare mounting space, and terminal strips shall have a minimum of 20% spare terminal blocks.

PART 3 - EXECUTION

3.01 GENERAL

A. Fabrication of panels shall not begin until shop drawing acceptance by the Engineer has been obtained.

3.02 INDOOR AND CONDITIONED AREA STEEL PANELS

A. General

1. Panels shall be fabricated from hot rolled metal (steel) especially selected for smoothness and flatness. Panels shall be fully enclosed, including top, with no visible seams on the front with a NEMA 12 rating.
2. Panel cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.
3. Components shall be mounted on removable subpans and not directly to the enclosures. Subpans shall be painted with a white enamel.
4. Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold the prints required to service the equipment.

B. Finish

1. After fabrication, welds shall be ground smooth, the panel shall be degreased, bonderized, and finished smooth with an epoxy filler and sanded. Two coats of a rust-inhibitor primer shall be applied. At least one coat of synthetic primer shall be applied, baked on, and sanded. This shall be followed by two coats of baked-on synthetic enamel. The first coat shall be sanded after baking. The average overall finish shall be at least five mils in thickness. Damage to the finish during installation shall be touched up at the job site as indicated in Section 09900 – Painting and Protective Coatings.
2. Interiors shall be given two coats of off-white semi-gloss.

   One gallon of touch-up paint shall be provided to the Owner for each type and color used for cabinet finish coats.

C. Access Doors

1. Each panel shall be provided with full height gasketed access doors. Doors shall be constructed from 14 gauge steel and provided with three point latches. Handles shall be padlock HASP and staple. Rear access doors shall extend no further than 24-inches beyond the panel when opened to the 90 degree position. Each door shall be provided with full length, continuous, piano type, steel hinges with stainless steel pins.

D. Free-standing Cabinets

1. Free-standing cabinets shall be provided with adequate internal bracing to support the weight of instruments and wiring. Internal bracing shall permit panel lifting without racking or distortion.
2. Removable lifting rings designed to facilitate simple, safe rigging and lifting of the panel during installation shall be provided. Plugs shall be provided to fill the lifting ring holes after installation and shall match the panel color.
3. The cabinet design shall be for front, top and rear access only to the extent available in the space shown on the drawings. Connections to and from the cabinets shall be through conduit to the top, except when otherwise indicated.

3.03 OUTDOOR AND NON-CONDITIONED AREA PANELS

A. Panels shall be constructed to NEMA 4X standards and shall be stainless steel.

B. Panel cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges. NEMA 4X integrity shall be maintained. Provide any necessary mounting kits or access doors.

C. The rear of panel mounted components shall be mounted on removable subpans and not directly to the enclosures.

D. Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required to service the equipment.

E. Doors shall be rubber-gasketed with continuous hinge.

F. Stainless steel panels shall be made of Type 304 stainless steel and shall have a brushed polished finish. Construction requirements are the same as for steel panels except painting is not required. Mounting brackets and hinges shall also be Type 304 stainless steel.

3.04 MANUFACTURER

A. Enclosures shall be as manufactured by Hoffman or equal.

3.05 INSTALLATION

A. Preparation and Shipping:
   1. Crate panels for shipment using a heavy framework and skids. The panel sections shall be cushioned to protect the finish of the instruments and panel during shipment. All instruments which are shipped with the panel shall further have suitable shipping stops and cushioning material installed to protect parts which could be damaged due to mechanical shock. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.
   2. All shipments shall be by air ride van, unless otherwise indicated.
   3. All control panel testing and inspection shall be performed before shipping.

B. Control panels shall be installed in accordance with Section 13000 – Instrumentation, Control and Monitoring System General Requirements.

3.06 CALIBRATION, TESTING, AND INSTRUCTION

A. General: Calibration and instruction shall be performed in accordance with Section 13000 – Instrumentation, Control and Monitoring System General Requirements.

B. Testing shall conform to the requirements of Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements.

C. Inspection and Approval:
   1. The panel fabricator shall conduct the following witness tests before shipment:
      a. All alarm circuits rung out to determine their operability.
      b. All electrical circuits checked for continuity and where applicable, operability.
      c. All nameplates checked for correct spelling and size of letters.
      d. Any other test required to place the panel in an operating condition.
   2. The Contractor shall furnish all necessary testing devices and sufficient manpower to perform the tests required by the Engineer.
   3. If the above tests have not been performed before shipment, the Contractor shall be liable for back charges by the Engineer for the extra time required for inspections.
   4. Each control panel shall be tested in the field for functional operation after the connection of external conductors, and before equipment startup.

END OF SECTION

SECTION 13300

INSTRUMENTATION, CONTROL AND MONITORING SYSTEM COMPONENTS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements of Division 1 of these Specifications and Section 13000 – Instrumentation, Control and Monitoring System General Requirements form a part of this Section. This Section specifies primary and secondary elements of process instrumentation, auxiliary equipment, and supplies directly related to the installation of and operation of these elements, to perform the required functions in conjunction with information and equipment specified in other Sections of Division 13.

B. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 13000 – Instrumentation, Control and Monitoring System General Requirements.
   3. Section 13200 – Instrumentation, Control and Monitoring System Panels.
   4. Section 13400 – Instrumentation, Operator Workstations, Human Machine Interface Terminals, and Programmable Logic Controllers.
   5. Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. Instrumentation Society of America (ISA).
      a. ISA S71.01 – Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
      b. ISA S71.02 – Environmental Conditions for Process Measurement and Control Systems: Power.
   2. International Organization for Standards (ISO).
      a. ISO 17025 – General Requirements for the Competence of Testing and Calibration Laboratories.
      b. ISO 9001 – quality management Systems – Requirements.
   3. International Electrotechnical Commission (IEC).
      a. IEC 61000 – Standards.

4. American National Standards institute (ANSI).
    a. ANSI B16 – Standard of Pipes and Fittings.
    b. ANSI/NSF Standard 61 – Drinking Water System Components.
5. National Electrical Manufacturers Association (NEMA).
    a. NEMA – Electrical Code.
6. Factory Mutual (FM).

1.03 SUBMITTALS

A. Contractor shall make submittals in accordance with Section 01300 – Submittals, and Section 13000 – Instrumentation, Control and Monitoring System General Requirements.

B. The following information shall be submitted:
    1. Six (6) copies of each of the following shall be submitted:
        a. Manufacturer's complete data.
        b. Shop Drawings, which include:
            i. Outline drawings of all components.
            ii. Schematic drawings of piping and wiring.
    2. Provide eight (8) copies of the following:
        a. Operation and Maintenance Manuals.
        b. Training documentation.

1.04 TESTING

A. A factory testing, field testing and final acceptance testing of system components shall conform to the requirements of Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements.

1.05 WARRANTY

A. Conform to warranty requirements of Section 13000 – Instrumentation, Control and Monitoring System General Requirements.

B. The equipment manufacturers and warrant and guarantee against defective equipment, workmanship and materials under normal use, operation and service, shall be for a period of 2 years after acceptance from the final date or resolution of the Owner accepting Work as substantially complete.

1.06 QUALITY ASSURANCE

A. Manufacturer
    1. In addition to requirements of Section 13000 – Instrumentation, Control and Monitoring System General Requirements, instrumentation and control equipment shall be manufactured by a firm regularly and currently engaged in the design and

manufacture of similar equipment. The equipment furnished shall be new and of current design.

B. Maintainability
   1. Equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation
   1. Materials and installation shall comply with the requirements of the current editions of referenced codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. Equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Contract Drawings or in Contract Documents.
   2. Field instruments with LCD displays shall be protected from direct sunlight by stainless steel sunshields.

PART 2 - PRODUCTS

2.01 INSTRUMENTS AND DEVICES

A. Flow Element and Transmitter, Electromagnetic
   1. General:
      a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
      b. Type:
         i. Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
         ii. Full bore meter with magnetic field traversing entire flow-tube cross section.
         iii. Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
      c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
   2. Service:
      a. Stream Fluid:
         i. As noted.
         ii. Suitable for liquids with a minimum conductivity of

             5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.

b. Flow Stream Descriptions: If and as described below.

3. Operating Temperature:
   a. Element:
      i. Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
      ii. Process: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      i. Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
      ii. Storage: 15 degrees F to 120 degrees F, typical, unless otherwise noted.
4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.
6. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
   a. Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.
   b. Liner Material:
      i. Polyurethane.
      ii. For potable water service, must have appropriate approvals.
   c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
   d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
   e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
   f. Grounding Ring:
      i. Required, unless otherwise noted.
      ii. Quantity: Two, unless otherwise noted.

iii. Material: Type 316 stainless steel, unless otherwise noted.

g. Enclosure: NEMA 4X, minimum, unless otherwise noted.

h. Submergence:

i. Temporary: If noted.

ii. Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.

i. Direct Buried (3 to 10 feet): If noted.

j. Hazardous Area Certification:

i. Class 1, Division 2, Groups A, B, C, D: If noted.

ii. Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.

iii. Class 1, Division 1, Groups C, D, and FM approved: If noted.

9. Transmitter:

a. Mounting: Surface (wall), unless otherwise noted.

b. Display: Required, unless otherwise noted.

i. Digital LCD display, indicating flow rate and total.

ii. Bi-directional Flow Display: Required, unless otherwise noted.

a) Forward and reverse flow rate.

b) Forward, reverse and net totalization.

c. Parameter Adjustments: By keypad or non-intrusive means.

d. Enclosure: NEMA 4X, minimum, unless otherwise noted.

e. Empty Pipe Detection:

i. If noted.

ii. Drives display and outputs to zero when empty pipe deleted.

10. Signal Interface (at Transmitter):

a. Analog Output:

i. Isolated 4 to 20 mA dc for load impedance from 0 to at least 500 ohms minimum for 24V dc supply.

ii. Supports Superimposed Digital HART protocol: If noted.

b. Discrete Outputs: If noted.

i. Two discrete outputs, typical, rated for up to 30 volts, typical.

ii. Programmable as noted for the following typical parameters:

a) High/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.

c. Discrete Input: If noted.

i. Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.

d. Other: As noted.

11. Cables:

a. Types: As recommended by manufacturer.

b. Lengths: As required to accommodate device locations.

12. Built-in Diagnostic System:

a. Features:
    i. Field programmable electronics.
    ii. Self-diagnostics with troubleshooting codes.
    iii. Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
    iv. Initial flow tube calibration and subsequent calibration checks.

13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Factory Ready for Future In situ Verifications: If noted.
    a. Original meter parameter values available from vendor by request.
15. Manufacturers:
    a. Emerson Process Management, Rosemount Division:
        i. Model 8705 (flanged) and Model 8711(wafer) flow tubes.
        ii. Model 8712 (surface) and Model 8732 (integral) transmitters.
    b. Krohne (includes IFC 020K/IFC 090K (integral) or IFC 020F/IFC 090F (remote) signal converter).
        i. Aqua Flux Flowmeter (Size: 3/8 to 120 inches).
        ii. EnviroMag, IFS 4000 Flowmeter (Size: 2 to 60 inches).
        iii. IFS 1000 EcoFlux Flowmeter (Size: 1/10 to 8 inches).
    c. ABB Automation MagMaster (includes Transmitter):
        i. 10D1475 Mini-Mag (Size: 1/10 to 4 inches).
        ii. MFE (Size: 1/2 to 24 inches).
        iii. Plus MFF (Size: 8 to 84 inches).

B. pH Element and Transmitter:
1. General.
    a. Function: Measure, indicate, and transmit pH of process fluid.
    b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.
2. Performance:
    a. Element:
        i. Range: 0 pH to 14 pH.
        ii. Operating Temperature: 32 degrees F to 158 degrees F.
        iii. Operating Pressure: 80 psig maximum at 149 degrees F.
    b. Analyzer/Transmitter:
        i. Range: 0 pH to 14 pH units.
        ii. Accuracy: Plus or minus 0.02 pH units.
        iii. Repeatability: Plus or minus 0.05 pH units.

iv. Stability: Plus or minus 0.01 pH units per month, noncumulative.
v. Operating Temperature: Minus 4 degrees F to plus 104 degrees F.
vi. Operating Humidity: 5 percent to 95 percent; relative humidity, noncondensing.

3. Element:
   a. Process Connection: 1-inch MNPT.
   b. Body Style: Convertible with 1-inch NPT on both ends.
   c. Process Fluid: As noted.
   d. Area Classification: Suitable for Class 1, Division 2 areas.
   e. Wetted Materials: Compatible with process fluid.
   f. No field-replaceable parts, unless otherwise noted.
   g. Electrode Type: Flat glass or general purpose, unless otherwise noted.
   h. Integral Preamplifier: Required, unless otherwise noted.
   i. Mounting/Process Connections: As shown on Drawings or as noted from among the following:
      i. Submersion:
         a) Sensor handrail assembly.
         b) Handrail mounting kit.
      ii. Flow-through:
         a) 3/4-inch NPT tee.
         b) 1-inch NPT tee.
         c) 1-1/2-inch NPT tee.
      iii. Insertion.
      iv. Hot-Tap Retractable:
         a) Suitable for 64-psig line pressure.
         b) 1-inch ball valve kit.
         c) Titanium Tube: 21 inches (12-inch insertion).
4. Analyzer/Transmitter:
   a. Display: Graphic LCD, with back-lighting.
   b. Signal Interface:
      i. Analog Outputs: Two isolated 4mA dc to 20mA dc outputs (pH and temperature).
      ii. Discrete Outputs:
         a) Process Alarms: Two SPSTs minimum, normally open.
         b) Sensor/Analyzer and Process Fault Alarm: SPDT.
         c) Contact Rating: 120 volts, 5 amps, resistive.
   c. Enclosure.
      i. Type: NEMA 4X.
      ii. Suitable for panel, 2-inch pipe, or wall mounting.
   d. Power: 115V ac, 50/60-Hz, unless otherwise noted.

e. Interconnecting Cable: Length as required.

5. Expendables (for each unit provided):
   a. Chemicals: 1 pint each of buffer solution for pH 4, pH 7, and pH 9.
6. Accessories:
   a. Junction Box: If noted.
      i. NEMA 4X box for cable extension.
      ii. Provide an air blast cleaning system for automatic cleaning of probe. Cleaning system shall be powered by controller; no separate power feed shall be required.
7. Manufacturers and Products:
   a. Hach; Digital Differential pH sensor and sc200 controller.
   b. Rosemount Analytical; Model 3900 sensor and Model 1056 pH controller.

C. Dissolved Oxygen Element and Transmitter, Non-membrane Luminescent (LDO):
1. General:
   a. Function: Continuous measurement of dissolved oxygen (DO) concentration of process fluid.
   b. Type: Luminescent sensor.
   c. Parts: Element (sensor), transmitter (analyzer), external power supply, interconnecting cable, mounting hardware, and ancillaries.
2. Performance:
   a. Range: 0 to 20 ppm.
   b. Sensor Accuracy:
      i. Measurement: plus or minus 0.2 percent of span.
      ii. Temperature: plus or minus 0.2 degrees C.
   c. Response Time: Less than 40 seconds to 90 percent of value upon step change.
3. Element:
   a. Luminescent sensor.
   b. Process Temperature Range: 32 degrees F to 122 degrees F.
   c. Submersion Depth: 350 feet maximum.
   d. Sensor Cable: Integral 33 feet of cable. Provide additional length as required.
   e. Junction Box: Provide junction or termination box and extension cable as required.
   f. Mounting: 1-1/2 UNF - 12 UNF thread.
4. Transmitter:
   a. Display:
      i. Graphic dot matrix LCD to display DO.
      ii. Auxiliary Readout:
         a) Temperature.
         b) Diagnostic warnings.
         c) Error messages.

d) Other information.

b. Ambient Conditions:
   i. Temperature minus 4 degrees F to plus 140 degrees F.
   ii. Humidity: 0 percent to 95 percent, relative, noncondensing.
c. Signal Interface:
   i. Analog Output:
      a) Two isolated 4mA dc to 20mA dc for load impedance up to 500 ohms.
      b) Either output configurable for DO or temperature.
   ii. Relay Outputs:
      a) Three SPST; 5 amps resistive, 115V ac/230V ac/30V dc.
      b) Each relay assignable to either DO or temperature.
      c) Function:
         i) Control: Settings for fail safe on/off, high/low phasing, set point, deadband, and on/off displays.
         ii) Alarm: Settings for fail safe on/off, high alarm point, high alarm point deadband, low alarm point, low alarm point deadband, and on/off relays.
   iii. Serial Communication: If and as noted.
d. Enclosure: NEMA 4X/IP66 polycarbonate/aluminum.
e. Mounting Hardware: Suitable to support panel, surface, horizontal pipe, and vertical pipe mounting.
f. Power Requirements: 120V ac, 60-Hz.
g. Stainless steel equipment tag.

5. Accessories:
   a. Unless otherwise noted, provide submersion mounting hardware and mounting bracket as required to perform appropriate installation.
   b. Provide sun shield for transmitter display.
   c. For all probes with submersion mounting, provide an air blast cleaning system for automatic cleaning of probe. Cleaning system shall be powered by controller; no separate power feed shall be required.
6. Manufacturers and Products:
   a. Hach; LDO Probe- Model 2 with sc200 Controller.

D. Level Transmitter (Submersible Head-Type)
   1. Type: Pressure sensor
   2. Transmitter: Control box with Local LED display of level in Feet and built-in power supply to convert 110/1/60 to 24 VDC for pressure sensor loop power. Control box to have one or two displays as required.
      a. Outputs: one or two 4-20 mA outputs
      b. Accuracy: 0.3% of full range
      c. Enclosure: NEMA 4X, polycarbonate housing

d. Power Supply: 120VAC, 1 PH, 60 HZ

3. Sensor: 316SS sensor housing and pressure sensor diaphragm with 33' of viton cable. Polarity independent leads for 24 VDC powered loop from transmitter. Atmospheric compensation tube built into cable. Range as specified on instrument chart.
4. Cleaning: Not required
5. Transmitter (Control Box) Mounting: mounted to 1/8" aluminum mounting plate with drip lid and SS hinged opaque sun shield.
6. Sensor Mountings:
   a. PVC hanger with minimum of 4" of cable contact and SS cable for hanging to eye bolt on side of tank or as specified on instrument chart.
   b. Slide Rail Mounting: Sensor supplied with two SS clips and 19" long SS Slide rail for wall mounting
7. Start-Up: provide minimum of 2 hours/meter of service by factory-authorized representative for system start-up plus ½ day of training.
8. Acceptable Manufacturer: Endress & Hauser Waterpilot FMX 21 model of approved equal

E. Liquid Level Transmitter (Ultrasonic)

1. The transmitter shall be of the ultrasonic time-of-flight type for continuous level measurement. The transmitter shall be integrated with an appropriate ultrasonic transducer to address the measurement application. The transducer portion of the transmitter shall have PVDF or PVDF/stainless steel diaphragm housings. Transducers shall have integral temperature sensors to support speed of sound compensation. The measurement resolution will be 1 millimeter (0.04-inch) with a measured error of 0.08-inch or 0.2% of set range (whichever is greater). The transmitter shall measure ranges of up to 50-feet. Output shall be proportional to level or volume.
2. The transmitter shall be microprocessor based with a removable plug-in operator interface that can be used in hazardous locations and is housed within a NEMA 6P corrosion resistant enclosure. There shall be no jumpers, trimpots, dip switches or external devices required to fully commission the transmitter. The plug-in operator interface shall have an alphanumeric display, a bar graph display and the capabilities to display the signal curve of the transmitter. All status messages, process variables and internal values shall be accessible and displayable on the plug-in operator interface. The transmitter shall contain a menu-driven guided setup procedure to allow untrained operators to commission without assistance. Three push buttons shall be provided to enter in information.
3. The transmitter(s) shall be loop powered via a 10 to 36VDC source or 4-wire sourced via 90 to 253 VAC or 10-32 VDC. HART communication shall be provided on the two loop powered 4-20 mADC output or on the active 4-20mADC when 4 wire sourced.
4. The transmitter shall support 32-point linearization (volume indication), fixed target suppression (mapping, removal of false echoes), first echo recognition (for correct indication despite double echoes) and agitator filtering algorithms.

5. The instrument shall include PC-based software for comfortable remote commissioning, advanced troubleshooting, documentation and backup of device settings.
6. The electrical classification should be general purpose, FM XP Cl.I Div.1 Groups A-G, FM IS Cl.I Div.1, Groups A-G, FM NI Cl.I Div.2, or FM DIP Cl.II Div.1, Groups E - G (FMU43).
7. The transmitters shall be manufactured in an ISO 9001 certified facility and meet CE requirements. Electromagnetic interference immunity (field strength 10V/m) and interference emission per NAMUR EN 50082-2 and EN 50081-1 is required.
8. The transmitter shall be Rosemount 3100 sensor with Rosemount 3490 Transmitter, Endress+Hauser Prosonic FMU 40, FMU 41 or FMU 43 or Engineer accepted equal.

F. Level Switch, Float

1. The level switch shall be a non-mercury PVC float switch with adjustable neoprene strain relief and flexibly supported by PVC jacketed, heavy-duty cable. The floats shall be mounted on a vertical 1 inch diameter corrosion resistant, rigid pipe attached to the structure wall with corrosion resistant brackets and Type 316 stainless steel hardware. Include all necessary accessories, supports and weights, for complete installation as specified and as shown on the drawings. The switch shall be rated at 10 amps at 115 VAc and shall be SPST-NO or SPST-NC as required. The float switch shall be Model T10 as manufactured by STI or accepted equal.
2. For float switch applications located in hazardous areas, intrinsic safety interface modules shall be provided. The module shall be a shunt diode barrier type of on/off switch circuit interface designed to maintain an intrinsically safe sensing circuit within Class 1, Division 1, Groups A, B, C, or D hazardous areas.

G. Pressure Transmitter, Electronic:

1. General:
   a. Function: Measure pressure and transmit signal proportional to pressure or level.
   b. Type: Electronic variable capacitance; two-wire transmitter; “smart electronics.”
   c. Parts: Transmitter and communicator.
2. Performance:
   a. Range: As noted.
   b. Maximum Adjustable Range: Noted range shall lie between 40 percent and 80 percent of maximum adjustable range.
   c. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
   d. Temperature: Operating range minus 20 degrees F to plus 250 degrees F, minimum.
   e. Humidity: 0 percent to 100 percent relative humidity.
3. Features:
   a. Type: Gauge pressure, unless otherwise noted.
   b. Damping: Fluid or electronic type with adjustment.
   c. Indicator: Four-digit LCD indicating noted range.

d. Suppressed or Elevated Zero: When noted.

e. Materials: Wetted parts including process flanges and drain/vent valves, Type 316 stainless steel, unless otherwise noted.

f. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.

g. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch or 1/4 inch, selectable.
   b. Connection Type: FNPT.
5. Provide Diaphragm Seal Assembly if noted.

6. Signal Interface:
   a. 4 mA dc to 20 mA dc output for load impedance of 0 ohm to

500 ohms minimum, without load adjustment with 24V dc supply.

   b. Digital process variable signal superimposed on 4-20 mA signal; support HART protocol type device.
7. Enclosure:
   a. Type: NEMA 4X, unless otherwise noted.
   b. Mounting: Pipe or wall as noted. Provide stainless steel brackets with stainless steel bolts.
   c. Housing: Modular with separate compartments for electronics and field connections. Epoxy coated aluminum, unless otherwise noted.
8. Communicator:
   a. Quantity: One per lot of Component P9 devices provided under Contract, unless otherwise noted.
   b. Features:
      i. Keypad and LCD display.
      ii. Program Memory: 8.0 MB, unless otherwise noted.
      iii. Transmitter Data: 2 KB, unless otherwise noted.
      iv. Battery Pack: Disposable AA 1.5V batteries, unless otherwise noted.
      v. Factory Mutual (FM) Intrinsic Safety Approval: Intrinsically safe for Class I, Division 1, Groups A, B, C, and D.
      vi. Manufacturer:HART.
9. Manufacturers and Products:
   a. Gauge Pressure Units:
      i. Rosemount; Model 2088.
         a) Diaphragm Seal 1199.
      ii. Foxboro; Model IGP10.

H. Pressure and Vacuum Gauges

1. General: Pressure and vacuum gauges shall, unless otherwise specified, conform with the following. Gauges shall be of the stem-mounting type unless panel-mounted type is shown on the Schedule. Refer to Section 15100 – Valves, for additional requirements.
2. Construction: Gauges shall be of the bourdon tube or bellows type with 270 degrees clockwise pointer travel. Dials shall be white with black numerals. Dial size shall be 4 1/2-inch. Panel-mounted gauges shall have round bezels for flush mounting and rear connection, others shall have a stem-mounting bottom connection. Connections for all gauges shall be male 1/2-inch NPT with square wrench flats. Wetted parts shall be corrosion-resistant to the process fluid shown in the Table A and unless specified in the Table A shall be the manufacturer's best quality standard. All dials shall be glycerin filled, hermetically sealed. Cases shall be black phenolic. Accuracy shall be ±0.5% of span.
3. Chemical Seal: Where used for sewage or sludge service, the gauge shall be furnished with a diaphragm seal unless specified elsewhere. Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing. The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid. The space between the diaphragm and the instruments pressure element shall be completely filled with a suitable fill liquid – defaulting to silicone oil. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch or any other pressure instrument. The diaphragm seal shall have a removable bottom housing to permit the servicing of the need to refill. All exposed surfaces, top and bottom housings, and diaphragm shall be constructed of Type 316 stainless steel as a minimum and shall be compatible with the process fluid. The process connection shall be a 3/4-inch threaded connection with a flushing connection.
4. Manufacturers: The gauges shall be as manufactured by Ashcroft Duraguage, U.S. Gauge, or user approved equal. The diaphragm seals shall be as manufactured by Ashcroft 200 series, Mansfield and Green SG Series, or accepted equal.

I. In-Line Pressure Seal

1. Where specified provide a pressure isolating ring that uses an elastomer membrane to isolate a pressure measurement from the process fluid in the pipeline. The membrane/diaphragm shall be providing direct contact with the process fluid but shall isolate the pressure measurement from the effects of solids, abrasives and slurries in the pipe line that would clog standard pressure sensing lines.
2. The pressure sensed by the membrane shall be transmitted to the associated pressure sensor, gauges, and/or transmitter via use of a suitable fill fluid – defaulting to silicone oil. Any air between the membrane and the associated pressure devices shall be fully evacuated during the filling process.
3. Inside diameter of the measuring membrane shall match the inside diameter of the associated pipeline.
4. Manufacturers: The in-line pressure seal shall be manufactured by Onxy Valve, Red Valve, or accepted equal.

2.02 MISCELLANEOUS

A. UPS - Uninterruptable Power Supplies

1. UPS systems shall be an on-line, computer-grade system. Unit shall consist of charger, batteries, inverter unit, on-line ferroresonant transformer for complete line isolation, synchronizing equipment, protective devices (include surge protection on line side), and accessories required to provide regulated, uninterruptable electrical power to the PLC, HMI, DC Power Supplies and to all other critical electronic components. Units shall include all mechanical and electrical devices that will provide continuity of electrical power within specified tolerances without interruption upon failure or deterioration of the primary power. Use of static transfer switch shall not be required.
2. Units shall include sealed no maintenance batteries capable of providing 30 minutes of full load backup power. Units shall be sized to provide a minimum of 25% unused capacity after full load calculations.
3. Submit sizing calculations to the Engineer for review.
4. Electrical Characteristics:
    a. Input:
        i. Voltage: 115 VAC, +- 10%.
        ii. Frequency: 57 to 63 Hz.
    b. Output:
        i. Voltage: 115 VAC +/- 3%.
        ii. Frequency: Synchronized to ac input line when on ac operation. When on batteries frequency shall be 60 Hz +/- .5%.
        iii. Harmonic Content: Maximum 5% total harmonic distortion.
5. Status and Alarms.
    a. Auxiliary contacts (SPDT) and all wiring and connections shall be provided for remote indication of the following UPS conditions:
        i. Main Power "On" Status (On/Off).
        ii. Inverter "On" Status (On/Off).
        iii. Battery Power "On" Status (On/Off).
        iv. UPS Trouble Alarm (Failure of UPS).
6. Bypass Switches: A bypass switch shall be provided to manually bypass the UPS for maintenance purposes. During bypass operation, the load shall be directly connected to the primary power source.
7. Unit shall be manufactured by Sola or approved by Owner equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Field mounted elements shall be installed, calibrated, and started up in compliance with the manufacturer's requirements and recommendations. Conflicts between the manufacturer's requirements and recommendations and these Contract Documents or the Contract Drawings shall be presented to the Engineer for resolution before any affected Work is started.

B. Connections of instruments to process piping shall include, as close as practical to the point of connection, a tight closing block valve suitable for the maximum process pressure and temperature and for the material involved. If connections are of threaded or welded pipe there shall be a union or flanged connection located in the piping to facilitate disassembly of the connection and removal of the instrument without interrupting process operation.

C. Unless specifically intended for such service, instruments shall be protected and isolated from vibration, temperature extremes, radiant heat, rain or falling water, and similar adverse conditions.

D. Impulse lines of pressure or pressure differential instruments shall be as short as practical and shall be installed with a minimum slope of 1-inch per foot (1:12) downward toward the instrument in liquid system and upward toward the instrument in gaseous systems. If this preferred direction of slope cannot be maintained, the Contractor shall submit for review and acceptance an installation configuration utilizing traps, drains, and/or vents at high and low points which will ensure freedom from mixed phase offset effects and provide ease of purging or draining. Exterior liquid filled lines shall be heat traced to prevent freezing.

E. Field mounted elements shall be marked with data required for calibration such as location of adjustments, span, off-set, zero suppression, and test voltages. If such data are not provided in permanent markings or on the manufacturer's nameplate, a durable tag or label shall be affixed in a protected location which will become readily visible in the normal course of servicing the instrument.

3.02 EQUIPMENT TESTING AND CALIBRATION

A. Factory Tests and Calibration. All field mounted elements shall be factory-tested by the manufacturer to assure satisfactory performance prior to shipment to the job site. Whenever possible, this shall include calibration to the actual range and conditions of use. Calibration shall be traceable to the national Bureau of Standards with an uncertainty not more than 1/2 of the specified or claimed accuracy of the instruments.

Field Tests and Calibration. Field mounted elements which were not calibrated to final project working values of range, span, and zero suppression at the factory shall be so calibrated prior to or at the time of installation. This calibration shall meet the same requirements of accuracy and

traceability required for factory testing above. The Engineer shall be given 48 hours notice and the opportunity to witness this calibration.

END OF SECTION

Supplemental document to Specification 13300
Spalding County WWTP and IPS Instrument List

#	Description	Required by NPDES Permit?	Required by SCWA/ or Stds?	Required by OSHA?	Use handheld probe instead?	Tag	Connected to Panel	Power	Supplied BY	Notes
Influent Pump Station										
	Submersible Pressure Transducer		y			PT-ISP-1	PCP-ISP-1	Loop powered	Pumps vendor	
	Backup Float Switch High-High		y			LSHH-ISP-1	PCP-1	N/A	Pumps vendor	
	Backup Float Switch Low-Low		y			LSLL-ISP-1	PCP-ISP-1	N/A	Pumps vendor	
	Pump #1 Discharge Pressure Transmitter		y			PIT-D-IPS-1	RTU-IPS-1	Loop Powered	System Integrator	
	Pump #2 Discharge Pressure Transmitter		y			PIT-D-IPS-2	RTU-IPS-1	Loop Powered	System Integrator	
	Discharge Flow Meter and Sensor		y			FE/FIT-IPS-1	RTU-IPS-1	120V, 1Ph	System Integrator	
	One (1) Smart Cover controllers with Subsonic sensors		y			LT-MH-1	N/A	Battery powered	System Integrator	
Wastewater Treatment Plant										
	Influent channel high-high float switch					LSH-101	RIO-101	N/A	System Integrator	
	Plant Influent flow meter/Magmenter		y			FE/FIT-101	RIO-101	120V, 1Ph	System Integrator	
	Influent channel pH Probe					AE/AIT-101	RIO-101	120V, 1Ph	System Integrator	
	Mechanical screen upstream level sensor					LE-101	FCP-101	N/A	Mech Screen Vendor	
	Mechanical screen downstream level sensor					LE-102	FCP-101	N/A	Mech Screen Vendor	
	Influent Sampler	y				S-101	RIO-101	120V, 1Ph	System Integrator	
	Blowers common header Pressure Transmitter					PIT-201	LCP-M	Loop Powered	Plant Package Vendor	
	Clarifier #1: High Torque Swirch					WSH-211	FCP-211	N/A	Clarifier Vendor	
	Clarifier #1: High-High Torque Switch					WSHH-211	FCP-211	N/A	Clarifier Vendor	
	Clarifier #1: Shear Pin Switch					XS-211	FCP-211	N/A	Clarifier Vendor	
	Clarifier #2: High Torque Swirch					WSH-212	FCP-212	N/A	Clarifier Vendor	
	Clarifier #2: High-High Torque Switch					WSHH-212	FCP-212	N/A	Clarifier Vendor	
	Clarifier #2: Shear Pin Switch					XS-212	FCP-212	N/A	Clarifier Vendor	
	Aeration Basin #1 DO Probe					AE/AIT-201	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #1 pH Probe					AE/AIT-202	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #1 ORP probe					AE/AIT-203	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #2 DO Probe					AE/AIT-211	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #2 pH Probe					AE/AIT-212	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #2 ORP Probe					AE/AIT-213	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #3 DO Probe					AE/AIT-221	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #3 pH Probe					AE/AIT-222	RIO-101	120V, 1Ph	System Integrator	
	Aeration Basin #3 ORP probe					AE/AIT-223	RIO-101	120V, 1Ph	System Integrator	
	Digester Basin #1 DO Probe					AE/AIT-231	RIO-101	120V, 1Ph	System Integrator	
	Digester Basin #1 pH Probe					AE/AIT-232	RIO-101	120V, 1Ph	System Integrator	
	Digester Basin #1 ORP Probe					AE/AIT-233	RIO-101	120V, 1Ph	System Integrator	
	Digester Basin #2 DO Probe					AE/AIT-241	RIO-101	120V, 1Ph	System Integrator	
	Digester Basin #2 pH Probe					AE/AIT-242	RIO-101	120V, 1Ph	System Integrator	
	Digester Basin #2 ORP Probe					AE/AIT-243	RIO-101	120V, 1Ph	System Integrator	
	RAS Flow Meter		Y			FE/FIT-251	RIO-101	120V, 1Ph	System Integrator	
	WAS Flow Meter		Y			FE/FIT-252	RIO-101	120V, 1Ph	System Integrator	
	Chlorine Analyzer (Contact Chamber)					AE/AIT-401	LCP-M	120V, 1Ph	System Integrator	
	ORP Probe (at chlorine contact chamber)		Y			AE/AIT-402	LCP-M	120V, 1Ph	System Integrator	
	Residual Chlorine Analyzer (Manhole)	y				AE/AIT-403	LCP-M	120V, 1Ph	System Integrator	
	Plant Effluent flow meter	y				FE/FIT-401	LCP-M	120V, 1Ph	Plant Package Vendor	
	Effluent Sampler					S-401	LCP-M	120V, 1Ph	System Integrator	
	Plant Drain PS: High-High Level Float Switch					LSHH-701	FCP-701	N/A	Pumps vendor	
	Plant Drain PS: High Level Float Switch					LSH-701	FCP-701	N/A	Pumps vendor	

	Plant Drain PS: Middle Level Float Switch					LSM-701	FCP-701	N/A	Pumps vendor	
	Plant Drain PS: Low Level Float Switch					LSL-701	FCP-701	N/A	Pumps vendor	
	Plant Drain PS: Low-Low Level Float Switch					LSLL-701	FCP-701	N/A	Pumps vendor	
	Water Tank Low Level Float Switch					LSL-801	MS-801	N/A	Pumps vendor	
	System Pressure Low Switch					PSL-801	MS-801	N/A	Pumps vendor	
	System Pressure High Switch					PSH-801	MS-801	N/A	Pumps vendor	
	Water Tank Low Level Float Switch					LSL-802	CP-802	N/A	Pumps vendor	
	System Pressure Low Switch					PSL-802	CP-802	N/A	Pumps vendor	
	System Pressure High Switch					PSH-802	CP-802	N/A	Pumps vendor	
	Emergency Eyewash High Flow Switgh					FSH-601	LCP-M	N/A	Shower Vendor	
	Plant Sewer PS: High-High Level Float Switch					LSHH-702	FCP-702	N/A	Pumps vendor	
	Plant Sewer PS: High Level Float Switch					LSH-702	FCP-702	N/A	Pumps vendor	
	Plant Sewer PS: Middle Level Float Switch					LSM-702	FCP-702	N/A	Pumps vendor	
	Plant Sewer PS: Low Level Float Switch					LSL-702	FCP-702	N/A	Pumps vendor	
	Plant Sewer PS: Low-Low Level Float Switch					LSLL-702	FCP-702	N/A	Pumps vendor	

Supplemental document to Specification 13300
Spalding County WWTP and IPS I/O List

#	Description	I/O Type	Associated Equipment Tag	Connected to Panel	Notes
Influent Pump Station					
	Phase loss Alarm	DI	PCP-IPS-1	RTU-IPS-1	
	Control Power On	DI	PCP-IPS-1	RTU-IPS-1	
	Wetwell High-high Level Alarm	DI	PCP-IPS-1	RTU-IPS-1	
	Wetwell Low-Low Level Alarm	DI	PCP-IPS-1	RTU-IPS-1	
	Pump #1 Running	DI	PCP-IPS-1	RTU-IPS-1	
	Pump #2 Running	DI	PCP-IPS-1	RTU-IPS-1	
	Pump #1 Common fault	DI	PCP-IPS-1	RTU-IPS-1	Combination of Moisture, Temperature and RVSS Fault
	Pump #2 Common fault	DI	PCP-IPS-1	RTU-IPS-1	Combination of Moisture, Temperature and RVSS Fault
	ATS in normal position	DI	ATS-IPS-1	RTU-IPS-1	
	ATS in Emergency position	DI	ATS-IPS-1	RTU-IPS-1	
	ATS Normal Power Loss	DI	ATS-IPS-1	RTU-IPS-1	
	Generator Running	DI	GEN-IPS-1	RTU-IPS-1	
	Generator Low Fuel	DI	GEN-IPS-1	RTU-IPS-1	
	Generator Common Fault	DI	GEN-IPS-1	RTU-IPS-1	
	Wetwell Level	AI	PCP-IPS-1	RTU-IPS-1	
	IPS discharge Flow	AI	FIT-IPS-1	RTU-IPS-1	
	Pump #1 Discharge Pressure	AI	PIT-D-1	RTU-IPS-1	
	Pump #2 Discharge Pressure	AI	PIT-D-2	RTU-IPS-1	
	Manhole Level from Smart Cover controllers	Comm Link	LT-MH-1	N/A	Satellite Connection
Wastewater Treatment Plant					
	Bar Screen Call To Run	DO	FCP-101	RIO-101	
	Bar Screen Running	DI	FCP-101	RIO-101	
	Bar Screen Auto Mode	DI	FCP-101	RIO-101	
	Bar Screen Common Fault	DI	FCP-101	RIO-101	
	Plant Influent Flow	AI	FIT-101	RIO-101	
	Influent Channel pH	AI	AE/AIT-101	RIO-101	
	Headworks channel high level	DI	LSH-101	RIO-101	
	Influent Sampler Common Fault	DI	S-101	RIO-101	
	Influent Sampler Flow Pace	AO	S-101	RIO-101	

	Aeration Basin #1 DO	AI	AE/AIT-201	RIO-101	
	Aeration Basin #1 pH	AI	AE/AIT-202	RIO-101	
	Aeration Basin #1 ORP	AI	AE/AIT-203	RIO-101	
	Aeration Basin #2 DO	AI	AE/AIT-211	RIO-101	
	Aeration Basin #2 pH	AI	AE/AIT-212	RIO-101	
	Aeration Basin #2 ORP	AI	AE/AIT-213	RIO-101	
	Aeration Basin #3 DO	AI	AE/AIT-221	RIO-101	
	Aeration Basin #3 pH	AI	AE/AIT-222	RIO-101	
	Aeration Basin #3 ORP	AI	AE/AIT-223	RIO-101	
	Digester Basin #1 DO	AI	AE/AIT-231	RIO-101	
	Digester Basin #1 pH	AI	AE/AIT-232	RIO-101	
	Digester Basin #1 ORP	AI	AE/AIT-233	RIO-101	
	Digester Basin #2 DO	AI	AE/AIT-241	RIO-101	
	Digester Basin #2 pH	AI	AE/AIT-242	RIO-101	
	Digester Basin #2 ORP	AI	AE/AIT-243	RIO-101	
	Clarifier #1 Call to Run	DO	FCP-211	RIO-101	
	Clarifier #1 Running	DI	FCP-211	RIO-101	
	Clarifier #1 Auto Mode	DI	FCP-211	RIO-101	
	Clarifier #1 Overload	DI	FCP-211	RIO-101	
	Clarifier #1 High-High Torque Switch Status	DI	FCP-211	RIO-101	
	Clarifier #1 High Torque Switch Status	DI	FCP-211	RIO-101	
	Clarifier #1 Shear Pin Switch Status	DI	FCP-211	RIO-101	
	Clarifier #2 Call to Run	DO	FCP-212	RIO-101	
	Clarifier #2 Running	DI	FCP-212	RIO-101	
	Clarifier #2 Auto Mode	DI	FCP-212	RIO-101	
	Clarifier #2 Overload	DI	FCP-212	RIO-101	
	Clarifier #2 High-High Torque Switch Status	DI	FCP-212	RIO-101	
	Clarifier #2 High Torque Switch Status	DI	FCP-212	RIO-101	
	Clarifier #2 Shear Pin Switch Status	DI	FCP-212	RIO-101	
	RAS Flow	AI	FE/FIT-251	RIO-101	
	WAS Flow	AI	FE/FIT-252	RIO-101	
	Aeration Blower #1 Call to Run	DO	VFD-201	LCP-M	
	Aeration Blower #1 Running	DI	VFD-201	LCP-M	
	Aeration Blower #1 Auto Mode	DI	VFD-201	LCP-M	
	Aeration Blower #1 VFD Fault	DI	VFD-201	LCP-M	
	Aeration Blower #1 Windings High Temp	DI	VFD-201	LCP-M	
	Aeration Blower #1 Speed Control	AO	VFD-201	LCP-M	
	Aeration Blower #1 Curent Monitoring	AI	VFD-201	LCP-M	
	Aeration Blower #2 Call to Run	DO	VFD-202	LCP-M	

	Aeration Blower #2 Running	DI	VFD-202	LCP-M	
	Aeration Blower #2 Auto Mode	DI	VFD-202	LCP-M	
	Aeration Blower #2 VFD Fault	DI	VFD-202	LCP-M	
	Aeration Blower #2 Windings High Temp	DI	VFD-202	LCP-M	
	Aeration Blower #2 Speed Control	AO	VFD-202	LCP-M	
	Aeration Blower #2 Curent Monitoring	AI	VFD-202	LCP-M	
	Aeration Blower #3 Call to Run	DO	VFD-203	LCP-M	
	Aeration Blower #3 Running	DI	VFD-203	LCP-M	
	Aeration Blower #3 Auto Mode	DI	VFD-203	LCP-M	
	Aeration Blower #3 VFD Fault	DI	VFD-203	LCP-M	
	Aeration Blower #3 Windings High Temp	DI	VFD-203	LCP-M	
	Aeration Blower #3 Speed Control	AO	VFD-203	LCP-M	
	Aeration Blower #3 Curent Monitoring	AI	VFD-203	LCP-M	
	Aeration Blower #4 Call to Run	DO	VFD-204	LCP-M	
	Aeration Blower #4 Running	DI	VFD-204	LCP-M	
	Aeration Blower #4 Auto Mode	DI	VFD-204	LCP-M	
	Aeration Blower #4 VFD Fault	DI	VFD-204	LCP-M	
	Aeration Blower #4 Windings High Temp	DI	VFD-204	LCP-M	
	Aeration Blower #4 Speed Control	AO	VFD-204	LCP-M	
	Aeration Blower #4 Curent Monitoring	AI	VFD-204	LCP-M	
	Blowers discharge air pressure	AI	PIT-201	LCP-M	
	Effluent Sampler Common Fault	DI	S-401	LCP-M	
	Effluent Sampler Flow Pace	AO	S-401	LCP-M	
	Plant Effluent Flow	AI	FIT-401	LCP-M	
	Chlorine concentraction (Contact Chamber)	AI	AE/AIT-401	LCP-M	
	ORP Probe (at chlorine contact chamber)	AI	AE/AIT-402	LCP-M	
	Residual Chlorineconcntration (Manhole)	AI	AE/AIT-403	LCP-M	
	Plant Drain PS: Pump #1 Common Fault	DI	FCP-701	LCP-M	
	Plant Drain PS: Pump #2 Common Fault	DI	FCP-701	LCP-M	
	Plant Drain PS: High Level Alarm	DI	FCP-701	LCP-M	
	Portable Water Boster Pump: Call to Run	DO	MS-801	LCP-M	
	Portable Water Boster Pump: Running	DI	MS-801	LCP-M	
	Portable Water Boster Pump: Auto Mode	DI	MS-801	LCP-M	
	Portable Water Boster Pump: Common Fault	DI	MS-801	LCP-M	
	Non-Portable Water Booster Pump #1: Call to Run	DO	CP-802	LCP-M	
	Non-Portable Water Booster Pump #1: Running	DI	CP-802	LCP-M	
	Non-Portable Water Booster Pump #1: Auto Mode	DI	CP-802	LCP-M	
	Non-Portable Water Booster Pump #1: Common Fault	DI	CP-802	LCP-M	
	Skid #1 Chemical Pump #1 Call to Run	DO	P-601	LCP-M	

	Skid #1 Chemical Pump #1 Running	DI	P-601	LCP-M	
	Skid #1 Chemical Pump #1 Auto Mode	DI	P-601	LCP-M	
	Skid #1 Chemical Pump #1 Common Fault	DI	P-601	LCP-M	
	Skid #1 Chemical Pump #1 Leak Detector	DI	P-601	LCP-M	
	Skid #1 Chemical Pump #1 Speed Control	AO	P-601	LCP-M	
	Skid #1 Chemical Pump #1 Speed Indication	AI	P-601	LCP-M	
	Skid #1 Chemical Pump #2 Call to Run	DO	P-602	LCP-M	
	Skid #1 Chemical Pump #2 Running	DI	P-602	LCP-M	
	Skid #1 Chemical Pump #2 Auto Mode	DI	P-602	LCP-M	
	Skid #1 Chemical Pump #2 Common Fault	DI	P-602	LCP-M	
	Skid #1 Chemical Pump #2 Leak Detector	DI	P-602	LCP-M	
	Skid #1 Chemical Pump #2 Speed Control	AO	P-602	LCP-M	
	Skid #1 Chemical Pump #2 Speed Indication	AI	P-602	LCP-M	
	Skid #2 Chemical Pump #3 Call to Run	DO	P-603	LCP-M	
	Skid #2 Chemical Pump #3 Running	DI	P-603	LCP-M	
	Skid #2 Chemical Pump #3 Auto Mode	DI	P-603	LCP-M	
	Skid #2 Chemical Pump #3 Common Fault	DI	P-603	LCP-M	
	Skid #2 Chemical Pump #3 Leak Detector	DI	P-603	LCP-M	
	Skid #2 Chemical Pump #3 Speed Control	AO	P-603	LCP-M	
	Skid #2 Chemical Pump #3 Speed Indication	AI	P-603	LCP-M	
	Skid #2 Chemical Pump #4 Call to Run	DO	P-604	LCP-M	
	Skid #2 Chemical Pump #4 Running	DI	P-604	LCP-M	
	Skid #2 Chemical Pump #4 Auto Mode	DI	P-604	LCP-M	
	Skid #2 Chemical Pump #4 Common Fault	DI	P-604	LCP-M	
	Skid #2 Chemical Pump #4 Leak Detector	DI	P-604	LCP-M	
	Skid #2 Chemical Pump #4 Speed Control	AO	P-604	LCP-M	
	Skid #2 Chemical Pump #4 Speed Indication	AI	P-604	LCP-M	
	Skid #3 Chemical Pump #5 Call to Run	DO	P-605	LCP-M	
	Skid #3 Chemical Pump #5 Running	DI	P-605	LCP-M	
	Skid #3 Chemical Pump #5 Auto Mode	DI	P-605	LCP-M	
	Skid #3 Chemical Pump #5 Leak Detector	DI	P-605	LCP-M	
	Skid #3 Chemical Pump #5 Common Fault	DI	P-605	LCP-M	
	Skid #3 Chemical Pump #5 Speed Control	AO	P-605	LCP-M	
	Skid #3 Chemical Pump #5 Speed Indication	AI	P-605	LCP-M	
	Skid #3 Chemical Pump #6 Call to Run	DO	P-606	LCP-M	
	Skid #3 Chemical Pump #6 Running	DI	P-606	LCP-M	
	Skid #3 Chemical Pump #6 Auto Mode	DI	P-606	LCP-M	
	Skid #3 Chemical Pump #6 Leak Detector	DI	P-606	LCP-M	
	Skid #3 Chemical Pump #6 Common Fault	DI	P-606	LCP-M	

	Skid #3 Chemical Pump #6 Speed Control	AO	P-606	LCP-M	
	Skid #3 Chemical Pump #6 Speed Indication	AI	P-606	LCP-M	
	Emergency Shower Flow detected	DI	FSH-EW-601	LCP-M	
	Well Pump Common Fault	DI	MS-WP	LCP-M	
	ATS in normal position	DI	ATS-800	LCP-M	
	ATS in Emergency position	DI	ATS-800	LCP-M	
	ATS Normal Power Loss	DI	ATS-800	LCP-M	
	Generator Running	DI	GEN-800	LCP-M	
	Generator Low Fuel	DI	GEN-800	LCP-M	
	Generator Common Fault	DI	GEN-800	LCP-M	
	Plant Sewr PS Wetwell High-High Level Alarm	DI	FCP-702	LCP-M	
	Plant Sewr PS Wetwell Pump #1 Common Alarm	DI	FCP-702	LCP-M	
	Plant Sewr PS Wetwell Pump #2 Common Alarm	DI	FCP-702	LCP-M	

SECTION 13400

INSTRUMENTATION, OPERATOR WORKSTATIONS, HUMAN MACHINE INTERFACE TERMINALS, AND PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SCOPE

A. General - This section describes the Programmable Logic Controller (PLC), Input/Output (I/O) equipment, Operator Interface Terminal (OIT), fiber optic industrial Gigabit Ethernet and associated network communication equipment, and associated hardware and equipment, PLC programming software, Human Machine Interface (HMI) SCADA application software including all engineering and programming and development required for monitoring and control. All devices, accessories, programming, and appurtenances required for proper operation of a complete and functional Instrumentation Control and Monitoring (ICM) system shall be provided.

1. The SCADA system shall be designed, coordinated, and supplied by a Control System Integrator (CSI) consisting of PLC based data acquisition and operator interface graphic display systems, who shall guarantee satisfactory operation of the installed ICM system.
2. Develop and provide the PLC and SCADA HMI and OIT graphic display applications programs and hardware configuration needed to monitor and control the process equipment to perform the functional requirements as specified in Division 13 Sections or as required by the process equipment manufacturers and as required by and described in these Contract Documents.
3. SCADA PLC's shall be configured and provided with hardware necessary to communicate with Ethernet enabled process instrumentation and equipment as required in these specifications.
4. In general, communication network from structure to structure shall be via industrial redundant, self-healing Ethernet optical fiber network. Each PLC and Operator Workstation shall be provided with a UPS with a 30-minutes full load minimum. In the event of local power failure, the PLC shall automatically stop fault sequencing, PID windup, and continue accumulation of data and process calculations while notifying the operator via the HMI screens. Communication shall continue with PLC and workstations.

B. Related Sections include but are not necessarily limited to:

1. Section 01300 – Submittals.
2. Section 13000 – Instrumentation, Control and Monitoring System General Requirements.
3. Section 13200 – Instrumentation, Control and Monitoring System Panels.
4. Section 13300 – Instrumentation, Control and Monitoring System Components.

6. Section 13450 – Instrumentation, Control and Monitoring System Testing Requirements.
7. Section 16120 – Wiring and Cable (600V).

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. National Electrical Manufacturers Association (NEMA).
   2. Instrument Society of America (ISA).

1.03 SUBMITTALS

A. The Contractor shall make submittals in accordance with Section 01300 - Submittals, and 13000 – Instrumentation, Control and Monitoring System General Requirements.

B. The following information shall be provided:
   1. Provide six (6) copies of each of the following shall be submitted:
      a. Manufacturers complete data.
      b. Shop drawings, which include the following:
         i. Outline drawings of all components and a composite drawing.
         ii. Schematic drawings of auxiliary piping and wiring.
   2. Provide eight (8) copies of each of the following shall be submitted:
      a. Operation and maintenance manual.
      b. Training documentation.

1.04 TESTING

A. Factory testing, field testing, and final acceptance testing of computers and programmable logic controllers shall conform to the requirements of Section 13450 – Instrumentation, Control and Monitoring Systems Testing Requirements.

1.05 WARRANTY

A. Conform to warranty requirements of Section 13000 – Instrumentation, Control and Monitoring System General Requirements.

B. The equipment manufacturers shall warrant and guarantee against defective equipment, workmanship, and materials under normal use, operation and service, for a period of 2 years after acceptance from the final date or resolution of the Owner accepting Work as substantially complete.

1.06 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as required. In addition, the following specific spare parts items shall be provided:

1. One of each type of CPU and co-processor module for PLC equipment furnished under this Contract.
2. One of each type of input/output module for PLC equipment furnished under this Contract.
3. One of each type and size of PLC and equipment power supply furnished under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Provide Programmable Logic Controller including necessary equipment and appurtenances as manufactured by the following acceptable manufacturer:
   1. Allen Bradley – CompactLogix.

2.02 PROGRAMMABLE LOGIC CONTROLLER AND I/O HARDWARE

A. General
   1. Provide PLC hardware including processors, power supplies, rack assemblies, interconnecting cables, grounding system, communication modules, hot standby modules, and accessories required to perform the control and monitoring functions.

B. Programmable Logic Controller (PLC)
   1. The PLC shall be provided with the following minimum features:
      a. The processor shall be the slot mount type, include at least 2MB available user memory. Minimum CPU shall be CompactLogix 1769-L32E or the latest model.
      b. The PLC system shall be able to accommodate the quantity and type of I/O points shown and described including future I/O points. In addition, provide 20% spare I/O points for each type, where a certain type of I/O is not required such as analog output, provide at least one such I/O module.
      c. The PLC system shall include one Ethernet communication module. Ethernet communication module shall be used for permanent system-type communications from PLC to PLC and to HMI operator workstations throughout the plant. Data transfer rate shall be up to 100Mbit/s.
      d. The PLC system shall operate over 0 to 60 degree Celsius temperature range, and a 0 to 95% (non-condensing) humidity range.
      e. The processor shall include diagnostic indicators for power, mode, low battery, communications ports, and memory and I/O errors.
      f. The PLC system shall allow on-line and off-line programming.
      g. The CPU’s shall have executive firmware which may be upgraded in the field using an upgrade/download procedure which does not require the removal and/or insertion of IC chip.

h. The PLC system shall be capable of communicating with third party devices such as Motor Control Centers, including Variable Frequency Drives (VFD), and packaged vendor equipment systems via Ethernet IP.

2. The PLC system in each control panel shall include a single or redundant processor (when shown on the drawings), power supply, and hot standby module. If the primary PLC system fails the standby PLC system shall assume primary control functions within 48 milliseconds of the failure. A failed component shall be able to be removed, replaced, and reloaded (with software) without shutting the on-line PLC system down. No special application programming shall be required to implement the hot standby PLC systems.

3. A power supply (quantity and size as required) shall be provided to supply power to the processor and I/O modules. The supply voltage to the power supply shall originate within the control panel and shall be 120 VAC. A separate 24 VDC power supply shall be provided to power the analog loops.

4. I/O modules shall be provided as required to accommodate the types and quantities of I/O points identified. Sample I/O point types include; dry contact outputs, 4-20 mAdc analog inputs, 4-20 mAdc analog outputs, and 120 VAC discrete inputs. Discrete inputs shall use 120 VAC as the voltage signal, and analog loop signals that leave the control panel shall use a 4-20 mAdc current signal. I/O module point density shall not exceed 16 points per module. Each I/O module shall include front panel mounted diagnostic indicators for point status, fault conditions, and active conditions. The I/O modules shall be able to be replaced while under power and shall be keyed to prevent the wrong type of module from being inserted in the wrong slot. All I/O modules shall have removable terminal blocks for termination of field wiring. All terminal blocks shall be ‘keyed’ to prevent application of terminal block to wrong I/O module. All I/O modules shall report to the CPU should a terminal block fail or be removed.

5. The PLC and I/O modules rack assemblies shall be housed in the control panels as specified in Section 13200 - Instrumentation, Control and Monitoring System Panels.

6. The control panels shall be provided with sufficient I/O modules to allow 20% spare installed and wired I/O points. Spares shall be provided for each different type of I/O.

7. The PLC and I/O equipment shall be a standard industrial grade product mechanically and electrically suitable for use in an industrial environment with a satisfactory product history of at least five years.

2.03 PROGRAMMABLE CONTROLLER APPLICATION & DEVELOPMENT SOFTWARE

A. The PLC programming and configuration software shall be the manufacturer's latest version, and compatible with the Windows 10 operating system. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. Programming shall be accomplished through the use of ladder logic and other IEC 1131.3 languages. PLC programming software shall include electronic documentation.

B. Third-party programming software shall be acceptable if recommended by the manufacturer and if that software exceeds the capabilities of the PLC manufacturer's standard software package.

C. All configuration and programming software necessary shall be provided on each operator workstation computer specified, including the Portable Laptop Programming Terminal, for connection to any PLC processor on the Ethernet network or via direct connection to the processor communications port. All necessary hardware drivers required to perform PLC configuration and programming shall be provided.

D. If available, the configuration and programming software shall support communication over the network to implement its functions remotely from an operator workstation. All configuration and programming software necessary to implement this functionality shall be provided on the SCADA System Operator Workstations. All necessary hardware and software drivers required to allow the operator workstation to perform PLC configuration and programming shall be provided.

E. The ladder logic instruction set for the PLC shall include the following, as a minimum:
   1. Relay type instructions.
   2. Counter and timer instructions.
   3. Comparison instructions (equal, greater than, limit tests, etc.).
   4. Integer and floating point mathematical instructions.
   5. Advanced math and trigonometric functions.
   6. Statistical instructions.
   7. Matrix and array instructions.
   8. Logical instructions (and, not, or, etc.).
   9. BCD conversion instructions.
   10. Bit modification, moving, and shift instructions.
   11. File instructions (search, copy, fill, etc.).
   12. Diagnostic instructions.
   13. Sequencer instructions.
   14. Program control instructions (jump, goto, subroutine, etc.).
   15. PID control loops.
   16. Block read and write capability.
   17. Send/receive messages.
   18. Immediate I/O and communications update instructions.

F. The PLC programming & configuration software shall be the latest version of RSLogix as required.

2.04 SCADA SYSTEM COMPUTERS

A. Control Room SCADA Operator WorkStation (OWS) with Dual 27” Monitors Hardware
   1. All operations SCADA system workstations shall be full function HMI SCADA nodes. The operating system shall be the latest version of Windows 11 Professional.

The HMI applications software shall be the latest version of VTSCADA, Wonderware, IFix or other approved equal.

2. All workstation computers shall be provided complete with Dual 27" Monitors, power supply, memory, keyboard, mouse, video display controller, 1,000VA UPS, Ethernet card, SSD storage drives, interconnecting cables, and accessories. Each workstation shall include Microsoft Windows 10 operating system, Microsoft Office package and shall be compatible with the HMI application software, PLC programming software, and PLC device driver software
3. Operator workstation computers shall be Dell Precision T3630 or accepted equal, with the following minimum features:
   a. Processor: Intel Xeon Processor E5-2286 (6 Core, 12 MB Cache, 4 GHz Turbo.
   b. Operating System: Windows 11 Pro
   c. Memory: 32GB 2x16GB DDR4 2933MHz RDIMM ECC Memory
   d. Keyboard: USB Entry Quietkey, No Hot Keys.
   e. Graphic Cards: NVIDIA Quadro P400, 5GB, 4 DP; Dual Monitor Capable.
   f. DVD, and_Read-Write_Devices: 16XDVD+/-RWand8XDVD,SATA
   g. Additional_PCI-E_Network_Adapter_card: Broadcom NetXtreme 10/100/1000 Gigabit Ethernet controller-PCI Express card.
   h. Mouse: Dell USB Optical Mouse with scroll.
   i. Hard Drive: HDD – 2TB and SSD – 256GB or sized as needed sized for data storage.
   j. Productivity Software: Latest Microsoft® Office Professional and Adobe Acrobat.
   k. Power: APC Back-UPS Pro 1000 VA UPS.
   l. Services: 3 Year ProSupport for IT and 3 Year NBD Onsite Service.

2.05 SCADA HMI APPLICATION SOFTWARE

A. Provide an operator interface software package that, when combined with the operator station computer hardware, will gather, display, and store real-time operating information. The operator interface software package shall be sized according to the appropriate I/O point count and shall be able to accommodate 20% additional I/O in the future, but as a minimum shall accommodate 10,000 I/O.

B. HMI Application Software
   1. The operator interface software package shall provide the following minimum functions:
      a. Compatible with Windows 10 Pro operating system.
      b. The software package shall be provided with the appropriate Ethernet driver software, Ethernet hardware interfaces, and required Ethernet communication/configuration interface software as required.
      c. The SCADA software shall be the latest version of VTSCADA, Wonderware, IFix or other approved equal for unlimited tag SCADA node on each workstation computer.

d. Database management shall be performed using Microsoft SQL Server Database. The ability to store historical data (analog or digital) to daily, weekly, or monthly files and the ability to archive historical data to tape.

e. Report writing software shall be the latest version of XLReporter by SyTech, Inc., or accepted equal. The system integrator shall coordinate directly with the owner on types of required report as well as the reports format, etc.

f. Analog data shall be configured to be stored as average, minimum, maximum, or instantaneous values, in the proper engineering units.

g. A complete alarm handling package shall be provided that shall annunciate alarms in an alarm queue and allow them to be displayed on the process graphic displays with messages or by changing colors or otherwise massaging graphic display symbols. An alarm summary screen shall be provided. Alarms shall be able to be acknowledged by an operator at the operator station CRT on an individual or screen basis and nuisance alarms shall be able to be disabled. Alarms shall be logged to the alarm printer.

h. Password protection for the various levels of access (day-to-day functions versus configuration changes), Log in and Log out at all times and Auto log off with set time.

i. The data base points shall be identifiable by tag numbers.

j. The entire system configuration, including database, shall be able to be backed up on Cloud Storage (cloud services shall be prepaid by the system integrator for at least 3 years) as well as a local External Drive.

2. Real Variables Processing.

a. Real Variables shall represent process data for which there are analog signal inputs to the system. The system shall sample each of these input signals at their selected scan frequency, and perform the proper conversions and scaling to obtain the instantaneous engineering values. These values then shall be used to update real-time data on CRT displays, check for alarm conditions, and store for use in the historical files.

3. Calculated Variables Processing:

a. Calculated variables shall represent process parameters for which there are no direct analog inputs to the system. These variables shall utilize Real Variables, and manually entered constants or laboratory data to compute their value.

b. There shall be two types of calculated variables defined:

i. Calculated Variables that utilize one or more Real Variables and/or manually entered constants. These variables shall be treated in the same manner as Real Variables and shall have the same attributes as Real Variables (including alarming and control), with the exception that the calculation shall be performed automatically every 5 seconds.

ii. Calculated Variables which are used only for the Daily, Monthly, and Annual Operation Summary reports, and which utilize laboratory input data shall be computed once a day for inclusion in the Daily report and stored for use in the Monthly and Annual reports. The capability to display these variables shall be provided.

c. The System shall provide for a minimum of 4096 calculated variables.

4. Manual Input Data Handling.
    a. The application software shall provide the capability to enter data manually from any operator's keyboard. This data shall consist of additional values for the current data file (e.g., laboratory analyses), inserting alarm limits, set point changes, adjustments to process constants, control system set point changes and system tuning parameter adjustments.
    b. All manually entered data shall be entered and stored in the appropriate engineering units. All data entered shall be displayed for confirmation on the data entry device prior to incorporation to the data base.

2.06 MANAGED ETHERNET SWITCHES

A. The managed Ethernet switch will be IEEE 802.3 compliant.

B. The switch shall be powered by a nominal 24VDC supply.

C. The switch will have a permissible voltage range of 18.5 VDC to 30.2 VDC

D. Switch will support redundant power inputs that allow immediate switchover without switch operation interruption.

E. The switch shall have an operating temperature range of 0°C to +55°C.

F. The permissible storage temperature range for the switch will be -20°C to +70°C.

G. The switch will withstand a maximum continuous operating humidity of 95% without condensation.

H. Units should be of fan-less design to increase reliability

I. Switching Capabilities:
    1. Auto-negotiation.
        a. All Copper TX ports will support auto negotiation.
        b. Each TX port will be able to interface to 10/100/1000 Mbps or full/half duplex devices.
        c. Fiber optic ports will support continuous 10/100/1000 Mbps full duplex communications.
    2. Auto Cross.
        a. All TX ports will support MDIX providing cable autocross capability.
    3. Auto Polarity.
        a. The switch will support automatic port polarity change in the event a pair of twisted pair receive cables (RD+/RD-) are connected incorrectly.
    4. Serial Interface.
        a. The device will have a V.24 RS232 communications interface.
    5. Accuracy & Capacity of switching table.

a. The switch will only forward valid Ethernet frames using the store and forward, or equivalent method.
b. The MAC address table will have a storage capacity of 8000 addresses.

6. Configurations.
a. The switch will support a removable memory device for the storing of switch settings, and the ability to share settings among like switches.

J. Diagnostics:
1. Port Status LED's.
a. Link: Each port will have an LED indication that there is a proper electrical connection to the attached device as well as providing indication that there is port activity.
b. Communication: Each port will have an LED indication for detection of packet collisions, and showing communication duplex mode.
c. To simplify the process of troubleshooting, the status indication of heavy communications traffic vs. the status of an active link with no communications traffic will be unambiguous.

2. LED Display.
a. The switch will employ a multi-position diagnostic display for reporting various startup and operational states, or error conditions that may occur.

3. Alarm Contact.
a. Switch to be equipped with an alarm contact to enable automatic audible or visual alarm in the event of loss of port communication, or either (or both) power supply inputs.
b. Switch to be equipped with an LED to indicate the status of the alarm contact.

4. Power Supply LED.
a. Switch will have a separate power indication LED for each power supply connection.

K. Internal Switch Functions:
1. Simple Network Management Protocol (SNMP).
a. The switch will support SNMP v1, v2 for network monitoring and configuration.
b. The switch will operate with any industry MIB browser.
c. Switch will have a system of fully configurable SNMP Trap messages.

2. Device Addressing.
a. The switch will, by default, support dynamic device addressing via BootP.
b. The switch will be capable of operation with a static IP address assignment.
c. Support for switch IP address assignment via DHCP will be available.
d. Switch address can be set via serial port connection.

3. Redundancy.
a. Rapid Spanning Tree Protocol (RSTP).
i. The switch will conform to the IEEE standard 802.1w for redundancy.

ii. The switch will support redundant port connections and loops without causing network operation failure
iii. The system of redundancy will be applicable for any network topology
iv. Entire redundancy method will be integral to the individual switch and not dependent upon a separate management device.

b. Fast Ring Detection (FRD).
i. The Switch shall support the RSTP extension Fast Ring Detection to enable data channel recovery times faster than standard RSTP.

c. Media Redundancy Protocol (MRP).
i. Switch will support MRP in accordance with the IEC protocol 62439.

4. Web-Based Management.
a. The switch will be programmed with an embedded web server.
b. The web server will provide a comprehensive configuration, and diagnostic mechanism for the switch.

5. Security.
a. The switch will provide the user the ability to entirely disable the Web-based management interface.
b. Switch will support an IP address based method for restriction of Web server access.
c. Modifications to switch settings will be protected by a user selectable/changeable password.
d. The switch will support an optional MAC address based mechanism for controlling port access.

6. Port Mirroring.
a. The switch will have the capability to send a copy of all network packets seen on one switch port to a network monitoring connection on another switch port.
b. The switch will support mirroring of both ingress and egress traffic.

7. Firmware Administration.
a. The switch will be structured so that future functionalities can be added through firmware upgrades.
b. The switch will have the capability to receive firmware upgrades as a field serviceable process.
c. Firmware upgrades will be performed via the integrated web server in conjunction with any TFTP server software, or via the serial connection.

8. IGMP Snooping and Query.
a. The switch will be capable of passively monitoring IGMP (multicast) messages and dynamically creating appropriate groups for proper message forwarding.
b. The query interval and snoop aging times will be user configurable to up to 60 minutes.
c. The switch will support up to 128 multicast groups.

9. Large Ring Networks.

a. The switch will support a configurable "Large Tree" extension to the Rapid Spanning Tree option, making a ring topology suitable for 28 switches along the relevant path from the Root.

b. This support option will provide the capability of constructing an RSTP ring topology of up to 57 switches, when all switches are configured with same function.

10. Traffic Prioritization.
    a. The switch will support multiple priority queues for adjusting the internal packet processing sequence.
    b. The switch will employ "Strict Priority" for transmitting data telegrams to ensure all high-priority data packets are transmitted.
    c. Switch will have a user settable internal prioritization for individual ports, so that the processing of Ethernet data for a particular port can be optimized.
11. Power over Ethernet (PoE).
    a. Switch shall provide support of Power over Ethernet in compliance with IEEE standard 802.3af.
12. Virtual LAN (VLAN).
    a. The switch is able to maintain up to 32 concurrent VLANs.
    b. The switch will support GARP VLAN Registration Protocol (GVRP) for dynamic VLAN implementation.
13. Link Layer Discovery Protocol (LLDP).
    a. The switch will support LLDP according to IEEE 802.1ab, for topology detection of devices that also have LLDP activated.

L. Managed Ethernet switches shall be Allen Bradley, N-Tron, Cisco, Phoenix Contact, Hirschman, or accepted equal.

2.07 UNMANAGED ETHERNET SWITCH SPECIFICATION

A. Ethernet Interfacing & Switching Capabilities
1. The Unmanaged Ethernet switch will be IEEE 802.3 compliant.
2. The switches must be capable of reading and processing high priority Ethernet packets before low priority during times of heavy network traffic in accordance with the priority levels of IEEE 802.1P/Q.
3. Auto-negotiation:
    a. All Copper TX ports will support auto negotiation. Each TX port will be able to interface to 10/100 meg or full/half duplex devices.
4. Auto Cross:
    a. All TX ports will provide cable autocross capability.
5. Accuracy & Capacity of switching table.
    a. The switch will only forward valid Ethernet frames using the store and forward or equivalent method.
    b. The address table will have a minimum capacity of 4000 addresses.

B. Diagnostics.
   1. Port Status LED's.
      a. Link Active: Each port will have a LED indication that there is a proper electrical connection to the attached device.
      b. Communications Status: Each port will have an LED indication of communications activity.
      c. To simplify the process of troubleshooting, the status indication of heavy communications traffic vs. the status of an active link with no communications traffic will be unambiguous.

C. Installation Requirements.
   1. Mounting.
      a. The Switch will be din rail mountable out of the box and without the need to add/assemble adaptor or similar mounting plates.
      b. All power connections will be wired using removable connectors.
   2. Port Security.
      a. The switch will be configured to accept optional security frames. When installed, these frames will lock inserted cables or plugs into place, then requiring the use of a small mechanical key for cable or plug removal.

D. Environmental Specifications & Agency Approvals.
   1. Temperature & Humidity.
      a. The Switch will have an operating temperature range of 0 to 60c or greater. For extended application life, the maximum temperature will be a minimum of 10 degrees C lower than the specified operating temperature of the internal switch chips.
      b. The switch will withstand a maximum continuous operating humidity of 95% without condensation.
   2. Electrical Noise Immunity.
      a. The switch will conform to the IEC61000-4-2 to 4-8 series of noise specifications as specified below:
         i. IEC 61000-4-2 Electrostatic Discharge: Criterion B.
         ii. IEC 61000-4-3 Radiated Noise Immunity: Criterion A.
         iii. IEC 61000-4-4 Fast Transient (Burst) Withstand: Criterion B.
         iv. IEC 61000-4-5 Surge Voltage: Criterion B.
         v. IEC 61000-4-6 Conducted Noise Interference: Criterion A.
         vi. IEC 61000-4-8 Electromagnetic Field withstand: Criterion A.
   3. Shock & Vibration.
      a. The operating shock rating will conform to IEC60068-2-27 and withstand a shock pulse of 25G or more for 11ms.
      b. The operating vibration spec will conform to IEC60068-2-6 (Criterion 3) at 5G 150Hz, in all 3 axis.
   4. Agency Certifications.

a. The switch will be certified for UL/Cul 508.

E. Unmanaged Ethernet switches shall be Allen-Bradley, N-Tron, Hirschman, Phoenix Contact, Weidmuller, or accepted equal.

2.08 ETHERNET COMMUNICATION NETWORKS

A. General

1. Ethernet links shall be provided to connect all PLC's to Network Interface Panels (NIP), Motor Starters (MCC), and Control Panels as shown on the Contract Drawings. The Ethernet communication system shall use modular rack or back of panel mounted components for interfacing with required field connections. Provide necessary racks, interface modules, gateways, segment couplers, power supplies, Fiber-to-Ethernet converters, fiber patch panels and all other components as necessary for a complete and operable Ethernet communications system.

PART 3 - **EXECUTION**

3.01 PROGRAMMABLE LOGIC CONTROLLER APPLICATION SOFTWARE & DEVELOPMENT

A. Provide programming to produce completely annotated application programs. Application programs shall be produced on equipment supplied by the Contractor as part of the Work. The application programming shall be developed as follows:

1. The application programs shall be developed in a neat, professional, logical, and efficient manner such that the available PLC memory is not wasted. The application programming shall be completely documented with detailed rung comments and address comments that correspond to tag numbers provided on the Contract Drawings or in the description of operation. Application programming that manipulates analog signals shall utilize values that are scaled in the proper engineering units and are of the correct magnitude. Formulas utilized shall be described in detail.
2. Use the system descriptions from Contract Drawings, process equipment manufacturer supplied information, and other application-oriented documents to develop the application programs.
3. The application programming shall account for the fact that an HMI operator interface will be communicating with the PLC. The programming and addressing schemes shall allow efficient and logical block mapping of points between the various pieces of equipment.
4. Provide programming package software and hardware tools at the conclusion of the Project, including USB Memory drives and reference manuals.

B. The manufacturer's license agreements for software packages shall be made out to the Owner.

3.02 SCADA HMI APPLICATION SOFTWARE DEVELOPMENT

A. Data Management.

1. The workstations shall scan the PLC's on demand and as necessary to retrieve and send analog, discrete and virtual input information for displays, control and related operator workstation functions. The current database shall be resident in the distributed network devices as appropriate.
2. Elapsed running time values shall be maintained in the database for all process drives. This data shall be expressed in hours and tenths of hours and shall be updated every sixty seconds using the last scanned value for each associated discrete input. Accumulated runtime data shall be periodically updated (once per hour) in disk memory. The exact time and date of initiation shall be maintained for each runtime accumulation. The operator may, at any time, from any operator workstation, access historical or current accumulated runtime values and either display or print reports containing accumulated runtime for certain specified equipment (i.e., sorted by accumulated hours, equipment ID, etc. within a user specified range) or all equipment. The operator shall be able to selectively reset any or all runtime accumulations to zero (or other legal values). The specified spreadsheet and database software shall be furnished with all required macros/applications to perform the reporting functions.
3. For reporting purposes, the database shall perform averaging and integration on a point basis over the following time periods:
    a. Five second – derived from readings accumulated at scan rates, stored for 3 days.
    b. Five minutes – derived from above 5-second valves, stored for 3 days.
    c. Hourly – derived from above five-minute values, stored for 1 year.
    d. Daily – derived from above one-hour values, stored for 1 year.
    e. Monthly – derived from above shift values, stored for 1 year.
    f. Annually – derived from above monthly values, stored for 1 year.

B. Graphic Display Organization - General

1. The display system described in the following paragraphs only defines those types of displays commonly used during normal operations and overall display organization. Displays shall be based upon information contained on the process flow diagrams, mechanical sheets, electrical drawings, other related drawings, and written narrative descriptions contained in the Specifications. The Contractor shall provide sufficient displays to satisfy all specified plant instrumentation and control system requirements
2. The description of the workstation operation in the remainder of this Section is based on the use of a mouse with screen icons. Should an alternate device be provided, operation shall be functionally equivalent to the procedures outlined below.
3. Alternative, but equivalent, graphic display formats and organization may be submitted for acceptance by the Engineer. However, any such substitutions shall conform to all functional requirements specified herein.
4. Each display format may consist of more than one page. If so, the display shall contain the message MORE (or other suitable descriptive text) as an icon on the

bottom line and the next page shall be obtained by a strike on the "page forward" (PF) or the MORE icon. Backpaging shall be accomplished by a strike in the "page back" (PB) icon.

5. The Page Forward (FRWD) and Page Back (BACK) icons shall permit the user to page forward and backpage on a multipage listing. If a listing is larger than the capacity of a single CRT page, a MORE icon shall appear on the display. MORE means that there is more data for this display which can be accessed a page at a time with the MORE or FRWD icon. The BACK icon shall be used to reverse the forward display sequence, a page at a time. FRWD or BACK icons shall not be used on a single page display.
6. For map based and/or site plan displays, system pan/zoom features as well as system vertical horizontal and vertical scroll bars may be used for this purpose.
7. Vector targets shall be employed to move vertically and laterally between related displays or, alternatively, the vertical and horizontal window can be used, where appropriate.
8. The formats for all schematic diagrams (e.g., unit process, process partition and control strategy diagrams) shall be based on the site plan, mechanical and electrical power distribution drawings and shall be submitted to the Engineer for review. Process displays shall generally be site plan oriented, unless otherwise accepted by the Engineer.
9. The operator screens shall be made of any number of the following components, as appropriate:
    a. Static and dynamic alphanumeric information.
    b. Static and dynamic graphic objects.
    c. Dynamic bar graph displays.
    d. Dynamic analog trending displays.
    e. Password protected operator actions.
    f. Screen navigation commands.
10. Dynamic analog information shall be capable of at least eight value related color changes with or without flashing in response to a change in value, state, or alarm condition for linked tags. Dynamic displays linked to digital tags shall be capable of displaying at least three states with corresponding color/flash indications.
11. All data displayed in operator screens on each workstation shall be valid and current. Current values displayed in operator screens shall be instantly replaced with an error indication for "bad" data, loss of data or loss of communications for each individual tag. These conditions shall be treated as alarms, with specified reporting and routing.
12. When communications are restored and/or errors are cleared, data displays shall automatically display actual values, and "change in status" messages shall be routed to all alarm reports and files.
13. While viewing screens, and through password access, operator interaction with individual, modifiable data points shall include: value changes; placing points on/off scan; manual/automatic mode changes; alarm acknowledge; alarm enable/disable; etc.

14. A "pick" point in an operator screen indicates possible operator interaction for data entry, screen navigation or task switching. When the mouse pointer is "dragged" across operator "pick" points, a highlight box shall appear around each. In addition to pointing and clicking, the operator may press the "down" arrow key, to select a "pick" point and then press enter.
15. Point-click procedures shall be available for all operator/screen interface for navigation, data entry, etc. Operator data entry procedures shall be configured as keyboard entry; point-click calculator; multiple choice point-click, up/down ramping or data value slide.
16. Provide user changeable lower, upper and rate-of-change limits on all screen setpoint entry points. Initial limits shall be set at: lower = 10%, upper = 85% and rate-of-change = 10% of value. The user shall not be able to enter setpoint changes beyond these valid limits.
17. Configure the software at each workstation to check, verify and require appropriate password login prior to each start/stop action, setpoint change, tuning parameter change or any other equipment control or functional change.
18. The system shall respond to each operator request to perform any of these actions in the following manner:
    a. Present a "pop up" start/stop faceplate screen with start and stop push buttons for each individually or grouped equipment start/stop system requirement.
    b. Present a "pop up" setpoint entry faceplate screen for each system setpoint change requirement.
    c. Present a "pop up" control parameter tuning faceplate screen for each system control parameter tuning requirement.
    d. English language operator prompting prior to any system response to operator request. Prompting shall inform the operator of the action about to be taken and provide a confirming "proceed" or "quit" choice.
    e. Each action and system response shall be clearly displayed in the appropriate "pop up" screen.
    f. System response indication shall be the most positive feedback required by this specification. At a minimum, the actual PLC register containing the data to be verified shall be displayed and shall be used for any sequential, interlocked or other related control scheme.
    g. At a minimum, each "pop up" screen shall provide for operator input/action and positive feedback indication. Each digital and feedback control display shall provide an English word rather than a digital number indicating conditions. These shall be: start, stop, enable, disable, etc.
    h. Each variable input shall allow operator keyboard or vertical slide bar data entry. Each variable, input, and feedback shall be displayed in number and bar graph formats, both individually and in color-coded multiple bar chart for system evaluation.
19. Objects in screens shall indicate field status, such as "stopped" or "running" by appropriate animation, positioning and color coding.
20. The software at all workstations shall be configured to allow password protected user screen configuration without the use of dedicated programmers, the need to change or reconfigure hardware or cabling, or the need to reboot.

C. Graphic Screen Navigation

1. Each operator screen display shall be configured with a multiple choice Menubar at the top of the screen. Each selection button shall display a related pull down menu of additional selections, screen navigation, system administration, diagnostics and task switching with appropriate password protection.
2. Each selection shall be made by a single point-click or by pressing the "down" arrow to the appropriate selection and then pressing [ENTER]. None of these selections shall cause screen updating, database updating, data collection, alarm monitoring or any other system function to pause or stop.
3. When a Menubar selection is made, the Menubar button and text for that selection shall protrude and become bold to positively indicate user's selection, and the pull-down menu shall be displayed. When pull-down menus are closed or when a new operator screen is displayed, Menubar selections return to previous, normal states.
4. Menubar selections and related pushbutton menu selections and functions shall include:
    a. SYSTEM Menubar selection: shall display a pull down menu with the following selections:
        i. SECURITY LOGIN selection: shall display a password login dialogue box, enabling the system user to login by entering an assigned login name and password.
        ii. SYSTEM ADMINISTRATION selection: shall provide a pull down menu with the following selections:
            a) SECURITY CONFIGURATION selection: shall display workstation security configuration dialogue boxes enabling the user, through password protection, to modify or disable/enable workstation security functions.
            b) FILE MANAGEMENT selection: shall provide the user with password protected access to Windows file manager.
            c) TASK MANAGER selection: shall provide the user with password protected access to the Windows Task Manager through which any Windows program can be run.
            d) HISTORICAL CHART CONFIGURATION selection: shall provide password protected access to workstation historical chart, pen and time group configuration through which the user shall be able to view, add and modify historical data charts.
            e) SYSTEM BACKUP selection: shall provide password protected access to the workstation on-board CD-ROM or tape drive backup function, through which the user shall be able to partially or totally backup workstation software files.
        iii. MESSAGE CENTER selection: shall provide access to a personal message center, through which users shall be able to provide brief messages to other users at any workstation on the network.
        iv. DIAGNOSTICS selection: shall display a pull down menu providing the following selections:

a) NETWORK STATUS selection: shall provide workstation network diagnostics indicating status of all network sessions, activity and trouble.

b) I/O COMMUNICATION STATUS selection (available on the field I/O server workstations): shall provide password protected interactive display indicating data request/transmit communications status and error conditions between the field I/O server workstation and the PLC data highway.

c) COMPUTER DIAGNOSTICS selection: shall provide password protected total workstation review and diagnoses of computer hardware, memory, drives, ports, etc. This function shall also provide hard copy reporting of the entire diagnostics review or any portion thereof.

v. FIELD I/O AND PLC CONFIGURATION selection: shall provide a set of screens for each PLC including:

a) Manufacturer

b) Model Number

c) Rack I.D.

d) Model number, type and location for each rack module.

e) I/O device, associated database tag, and module position for all field I/O points.

vi. SYSTEM ACTIVITY selection: shall provide a password protected pop-up display of live system activity including alarms, alarm resets, operator entries, communication errors, system messages and database configuration activity. This display shall be used to provide real time feedback for operator requests, troubleshooting, alarm management assistance, etc. This pop-up display shall be sized, moved, closed and set to be always "on-top" during screen navigation by user request and at any time without pausing or stopping data updates, data collection or alarm monitoring.

b. ALARM Menubar selection; shall provide user interactive alarm summary screen as specified in the alarms section of this specification.

c. HELP Menubar selection: shall provide project-specific full-function Microsoft Windows help including: "contents", "search", "back", etc.

d. TREND Menubar selection: shall provide a pull down menu selection listing for:

i. LIVE TREND choice: shall provide a multiple trend menu of predefined live trends.

ii. HISTORICAL TREND selection: shall provide a menu selection listing of predefined historical trends.

e. REPORTS Menubar selection: shall provide access to a menu listing for all configured reports with features as described herein.

f. DISPLAY MENU Menubar selection: shall display a menu of all plant area displays for screen navigation.

g. OVERVIEW Menubar selection: shall display the plant overview screen.

h. PRINT Menubar selection: shall print the current display.

i. CONTROL PANEL Menubar selection: shall provide date and time display and access to Microsoft Windows Control Panel. A single point-click action from a supervisor's security level or above shall display the Control Panel icon group through which modification can be made for:

i. System Date and Time.

ii. System Fonts.

iii. Printers Setup.

iv. Other Standard Windows Control Panel Functions.

D. Process Overview Display(s)

1. The process overview graphic display shall be obtained by selecting the OVERVIEW icon. One or more targets or icons shall be provided for each unit process and shall permit the operator to directly access an associated unit process display. The plant site plan layout shall be used as the basis for the process overview display, which shall provide display vectoring functions to subordinate unit process displays. A separate display containing a text-based listing of all system graphic displays shall also be provided, accessible from the Overview Display or a separate Menubar selection.

2. Intermediate process overviews shall be provided to summarize information from a number of similar or identical unit process equipment items (e.g., filter overview showing all filters, aeration system overview, etc.). These intermediate overview displays shall allow vectoring to/from the plant overview(s) and the individual equipment detail displays, and shall show appropriate summary process data.

E. Functional Area Display (s)

1. Functional Area Display(s) Unit Process Graphic Displays shall be provided to show all plant process areas and equipment in detail. Except where specified otherwise, all operator control actions shall be performed at the Unit Process Display level. Any unit process display shall be selectable from the process overview display or from an adjacent process area or otherwise related process display. A unit process display shall be a schematic representation of a process and use standard symbols to represent process equipment such as pumps, tanks, motors, etc. Process status shall be indicated using both color and alphanumeric annotations. Symbol color coding for all displays shall be based on the following convention:

2. All text shall be shown in white except alarm condition statements that are illuminated in either yellow or magenta.

a. Yellow blinking = device has a noncritical alarm not yet acknowledged.

b. Yellow = device has a noncritical alarm that has been acknowledged.

c. Magenta blinking = device has critical alarm not yet acknowledged.

d. Magenta = device has a critical alarm that has been acknowledged.

e. Cyan = device off or not available. This may represent future equipment or equipment that has been taken off line for maintenance purposes.

f. Red = device is on, running, energized, open.

g. Green = device is available, ready to run, de-energized, closed.

h. White with a black target background = device is in automatic (or semi-automatic) control mode.

i. White with a blue target background = device is in manual mode.

3. The displays shall show all ID number, current status values and setpoints associated with a given process display and shall be updated with current values every five seconds or less.

4. The control status of each controllable device shall be modifiable and shall be displayed in text adjacent to that device. Control status shall be AUTO, MANUAL, AVAILABLE, etc., and shall be updated continuously. When the operator wishes to take control of the device or modify setpoints, the procedure shall be as follows:

a. The operator shall click on the device symbol with the mouse.

b. A dialog box shall appear which provides the current state or setpoint and enables the operator to make the appropriate change.

c. For two-state devices, the dialog box shall allow the operator to start or stop, open or close, or otherwise change the state of the device.

d. For setpoints and modulating final control devices (analog outputs), the dialog box shall display the old value, and shall allow the operator to enter a new value using standard Windows editing techniques. It shall also be possible for the operator to ramp the current value up and down by clicking on ramp targets.

e. Prior to the execution of the operator-commanded action, a confirmation message and target shall be displayed stating the old and new values and asking the operator to confirm the modification.

f. Control strategies shall be changed from AUTO to MAN or OFF (or vice versa) in the same manner as two-state devices.

F. Alarm & Event configuration

1. The operator workstation software shall be configured to provide alarm handling, reporting and archiving. Alarm grouping, printing and display shall be coordinated with Engineer and Owner prior to configuration.

2. Alarm management shall be provided for each database field input and shall include:

a. Alarm reporting enable or disable.

b. Alarm suppression to avoid nuisance alarms such as start up spiking.

c. Re-alarming.

d. Alarm routing to specific workstations and printers as appropriate.

e. Alarm grouping for specific visual and audible group notification.

f. Analog alarm types to include at least: low low; low; high; high high; rate of change; deviation; deadband; bad input; and off scan.

g. Discrete alarm types to include at least: change from normal; return to normal; change of state; bad input; and off scan.

h. Alarm acknowledgement and condition clear format.

3. The operator workstation software shall provide date and time stamped alarm reporting to at least five destinations. These destinations shall be:

a. Operator screen alarm summaries.

b. Alarm printers.

c. System alarm and history file.
d. System alarm and history display.
e. Workstation network.

4. All points or modules that have the capability of being alarmed for amplitude or rate of change limit violations, and all discrete alarm inputs shall be linked to an associated discrete point for alarm suppression under specified conditions. For example, when there is no flow through a flow meter, the "not running" signal from the associated prime mover shall be used to suppress all alarms associated with the flow signal. Time delays shall be provided as necessary to eliminate transient alarm annunciation under start-up/shutdown conditions.
5. All alarms shall be OLE and Windows Sound System enabled. Sound files shall be individually assigned to each alarm point.
6. The system shall provide an alarm summary display as a pre-defined dynamic link within the graphics package. This alarm summary display shall show a list of the pending alarms in the system. As new alarms are detected, entries shall be made to the display list. As the alarm conditions clear, the entries shall be removed from the list.
7. The alarm summary display shall be user-configurable to the extent that the user can select the placement of tag name, current value, descriptor, time of alarm, and alarm status on the line as well as the color codes to be used to indicate the various alarm conditions.
8. Only alarms, including the loss of network, data highway and individual field I/O point communications, shall be reported to operator screen alarm summaries, which shall allow the operator to sort alarms in descending or ascending time order. The operator shall also be allowed to apply various priority level filters and to reconfigure alarm summary columns for detailed analyses, while viewing.
9. Alarms shall be acknowledged from the alarm summary display either individually (by clicking on an alarm acknowledgement field) or by a full page using a menu pull-down. The system shall support up to twenty (adjustable) alarm messages in the summary display.
10. Each graphic display shall be configured with the indication of the last three alarms at the bottom of the screen.
11. An unacknowledged alarm shall flash in configured foreground/background colors until it is acknowledged. When an alarm is acknowledged, it shall stop flashing but remain displayed until the alarm condition is cleared.
12. When an alarm condition has been both acknowledged and cleared, the alarm statement shall be removed from the alarm summary.
13. Alarm summaries shall use system colors and provide at least the following column information:
    a. Date and time.
    b. Workstation name.
    c. Tag number.
    d. Tag description.
    e. Alarm condition.
    f. Tag value.

14. Configure alarm summaries with a distinctive color format for:
    a. Background color.
    b. High value alarms.
    c. Low value alarms.
    d. Rate-of-change alarms.
    e. Digital status alarms such as change of state, change from normal, etc.
    f. Plant area/access alarms.
15. The following color codes shall be used in conjunction with alarm displays:
    a. Cyan = normal.
    b. Yellow, blinking = noncritical, not acknowledged alarm.
    c. Yellow = noncritical, acknowledged alarm.
    d. Magenta, blinking = critical, not acknowledged alarm.
    e. Magenta = critical, acknowledged alarm.
16. The following alarm condition statements shall be provided as a minimum:
    a. RTN NRML - Return to Normal.
    b. HIHI LMT - Second High Limit.
    c. HI LMT - High Limit.
    d. LO LMT - Low Limit.
    e. LOLO LMT - Second Low Limit.
    f. ROC LMT - Rate of Change Limit.
    g. STAT CHGE - Status Change.
    h. OFF SCAN - Off Scan.
    i. OPEN FAIL - Open Failure.
    j. CLOSE FAIL - Close Failure.
    k. START FAIL - Start Failure.
    l. STOP FAIL - Stop Failure.
    m. FAULT – Fault.
    n. HI DEV - High Deviation.
    o. LO DEV - Low Deviation.
    p. DISCREP – Discrepancy.
    q. UNAVAIL – Unavailable.
17. Date and time stamped alarm reporting shall be sent to alarm printers with similar formatting, configuration and routing procedures as specified for alarm summaries.
18. Configure alarm and history files for sequential date and time stamped activity reporting for the entire system, on each workstation. This file shall be a daily text file with a file name indicating the date that the file was created, and shall include all system wide activity including:
    a. Alarms.
    b. Alarm acknowledgement.
    c. Loss and recovery of network, data highway and individual field I/O point communications.

d. Status changes.
e. Alarm clear and return to normal messages.
f. Operator keyboard entries.
g. Other system related activity (system startup, save/reload database, etc.).

19. Information format shall include:
    a. Date and time.
    b. Description.
    c. Condition.
    d. Current value.
20. Alarm and history files shall be saved to computer backup media including CD's or tapes if selected by the operator.
21. The alarm and history display shall provide live viewing of alarm and history file entries, giving the operator instantaneous activity review and operator action verification.
22. The system alarm and history display, with on-line height and width adjustment capabilities, shall be displayed as part of operator screens, upon demand. The operator shall be able to size and move the display, as desired. Further, the operator shall be able to close this display, upon demand, or cause it to be continually displayed as the operator navigates through operator screens.
23. The opening, closing, moving or resizing of this display shall not cause screen updating, database updating, historical data collection, alarm monitoring or any other system function to pause or stop.
24. Workstations shall be configured to report all alarm conditions, operator activity, etc. to all other workstations.
25. The system shall be configured to provide a periodic date stamp on the alarm printout at the alarm printer to provide clear date/time evaluation of printed alarms.
26. Each workstation shall be configured for alarm and history activity file backup and archiving to the on-board tape or CD drive. Provide alarm and history file backup, and disk space management procedures.

G. System Security
1. Observer.
    a. Graphic display viewing and navigation.
    b. Historical data display.
    c. Password login and logout.
    d. Observer shall be the system default security mode.
2. Operator.
    a. Observer privileges.
    b. Password protected start/stop, setpoint entries, system activity display, etc.
    c. Lead Operator/Supervisor.
    d. Operator privileges.
    e. Historical data chart configuration.
    f. Report viewing, modification and exporting/printing.

g. Task switching to the Windows operating system.
h. Software system shut down.
i. Windows NT Task Manager access.

3. System Administrator/Engineer.
   a. All privileges.
4. The software at each workstation shall be configured to automatically log in the observer group upon system startup.
5. The security system at each workstation shall be configured to not allow SCADA software shut down or Windows NT security access unless requested through Supervisors' or System Administrator security privileges.
6. The security configuration shall be exportable to a text file, which shall not include passwords. This text file shall have a user defined acronymic, mnemonic file name and shall be capable of being imported into the system to modify or create workstation security configuration.
7. All workstation security activity, including violations, shall be reported in a date and time stamped format to a daily text file for review and evaluation at any time. This security text file shall have a file name indicating the date that the security file was created. It shall be possible for any text editor to edit these files.
8. Each workstation shall be configured for security activity file backup and archiving to the on-board tape drive.

H. Trend Configuration
1. The system shall provide multiple sets of live trends in operator screens. Each set of live trends shall be capable of the following:
   a. Displaying up to eight pens.
   b. Being temporarily modified, while viewing.
   c. Displaying straight line or varying data value "target" curves.
   d. Full screen trend curve displays when trend screen is opened.
2. Each live trend chart shall allow temporary, on-line pen, range and chart X-Y parameter changes by the user. Each trend display shall allow on-line user modifiable straight-line "target" curve for each trended data point and, as specified, a user selected varying data value "target" curve based on pre-defined modeling for trended data points.
3. Trends shall automatically shut down and release system resources when closed.

I. Historical Data Management Configuration
1. The operator workstation SCADA, database, spreadsheet and reporting software shall be configured to provide historical data gathering for system and operations validating, testing, maintenance and regulatory reporting.
2. The system shall provide multiple choice options for historical data file size and shall automatically assign file names indicating the date and duration for data contained in each file. The installed system shall be configured for sequential data files beginning at midnight.

3. For data and system resource management the system shall allow the assignment of any number and type of database tags and tag groups for historical data collection with the following attributes:
    a. Collection rate and phasing.
    b. Data collection start/stop condition.
    c. Data collection deadband.
4. For additional resource management, the operator workstation software shall be configured to automatically delete historical data files when they reach a certain age, which is user selectable from a multiple choice options list. Set initial automatic file deletion at 20 days with backup and archiving procedures occurring prior to deletion.
5. Configure each workstation for historical data files backup and archiving to Cloud Storage and local external Drive.
6. Provide historical data files backup, and disk space management procedures.
7. All attributes of each historical display chart shall be able to be configured or modified at any time.
8. In addition, the user shall be able to make temporary, view only modifications, while viewing historical trend charts.
9. The system shall be configured for the following on-line historical data user functionality, without pausing or stopping any system function:
    a. Zoom to any specific area of a chart.
    b. Automatic real time update of historical data, upon demand.
    c. Reset to original trend chart parameters, upon demand.
    d. Request completely different start/stop time and duration parameters, upon demand.
    e. Chart data display update forward or backward in time, by a single point-click for two sets of modifiable time increments in each direction.
    f. Export displayed trend chart data into a text file with a user defined acronymic, mnemonic file name.
    g. Print any displayed historical trend chart, upon demand.
    h. Display multiple historical trend charts at the same time with time synchronizing for detailed analyses.
    i. Data trend charts configured by combining any pen and time groups.
    j. Trend chart display format changes including colors, titles, legends, etc.
10. When configuring tag pen groups, the system shall provide for user configuration of at least:
    a. Individual tag and related attributes.
    b. Default or specific data value range.
    c. Individual color for each tag pen.
    d. A specific letter to further document each pen related curve.
    e. Trend chart display format.
11. Time group configuration shall include at least the following:
    a. Start/stop dates and times.

b. Duration.
c. Sample, average value, high value and low value displays individually or together.
d. Trend chart display format.

12. Historical data files shall be saved to computer backup media including diskettes, tapes or optical disks if the operator chooses this option. The system shall allow these files to be restored to the appropriate system file path and reviewed with all system functions at any time, as if they had continued to be hard disk resident.
13. The collection of historical data shall begin automatically upon software system start-up.
14. All analog and digital field inputs shall be historically collected. Provide collected data in the "sample" mode with collection rate, phasing, etc. attributes assigned to maximize data collection and system resources.
15. Provide the following time groups:
    a. The previous hour.
    b. The previous twenty-four (24) hours.
    c. The previous thirty (30) days.
16. Operator access for viewing or printing any individual project specific, pre-defined historical trend chart shall be through a single point-click action while viewing operator screens via the TREND Menubar selection.

J. Reports Configuration

1. The report generator shall employ the specified electronic spreadsheet, report writing and database programs to provide the user with an interactive method to define, change, and replace report formats. The specified database, spreadsheet, and reporting software shall be furnished with all required applications and macros to perform the specified reporting functions.
2. The report generator shall permit arithmetic, relational, logical and statistical operations on individual or groups of data values contained in the distributed database and shall be employed to build shift, daily, equipment runtime and other specified reports utilizing network based dynamic data exchange access to the databases.
3. The reporting module shall provide the user with all standard Excel-type interactive spreadsheet formats, functions, linking, various kinds of charts, live spreadsheet/database interaction, fonts, math functions, macros, print options, and report saving.
4. All tags in the Control and Information System, including inputs, outputs, calculations and historical data shall be available for use in reports. Points shall be referenced in report formats by tag names or pen/time groups, and linking to reports shall be automatic and transparent to the user.
5. Each report shall be capable of linking and displaying the following:
    a. All attributes of database tags including:
        i. Current value.
        ii. Engineering units.
        iii. Descriptors.

iv. Field I/O equipment addresses.

v. Alarm parameters.

b. Any combination of historian pen/time groups.

c. Manually entered data.

d. Text.

e. Date and Time.

6. The report package shall allow on-line user selection of a value or groups of values, and instantaneously create charts in X-Y, bar graph, pie and other formats. Charts shall be modifiable upon viewer demand. Chart printouts, on demand, shall be provided.

7. Reports shall display entries indicating "no data" and "bad data" to distinguish error conditions from zero values for individual report data links.

8. Report generation or configuration shall not cause screen updates, database updates, historical collection, alarm monitoring nor any other system operation to pause or stop.

9. The report module shall open on top of operator screens, so that, upon exiting, the previous operator screen shall be automatically displayed, and shall be fully functioning and updating.

10. The reporting of system operating data shall occur once per day at user-specified times. Data recorded on these reports shall be extracted from the operator workstation data files as required. Report data shall consist of the arithmetic average and sums of variable readings taken by the control system on scans made during the previous 24-hour period and from manually entered data. Where applicable, total, average, maximum, and minimum values shall be provided for each column of data on each report.

11. User access to any individual report shall be provided by means of a single point-click from a menu of all project specific reports.

12. Password protected access to reports shall also enable the user to create and/or modify reports through standard Microsoft Excel configuration and system macro procedures.

13. No reports access, work, viewing or any other reports related activity shall require the suspension, modification or the stopping/starting of the reports scheduler. Nor shall this activity cause any pausing or stopping of data updating, data collection, alarm monitoring, or any other Control and Information System function.

3.03 SYSTEM CONFIGURATION AND EXPANSION

A. The system shall provide an on-line installation and configuration program for configuring the various computers on the network. This configuration software shall allow assigning unique node names to each computer as well as selecting the functions that the machine will perform.

B. The system shall allow additional computers to be added to the network while on-line, without disrupting the operations of the other machines.

3.04 DIAGNOSTICS

A. The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.

B. An additional display shall show the current session status (established, pending, offline) of all stations on the network. A session monitor program that automatically monitors and recovers communications shall be supplied with the system.

3.05 LICENSE AGREEMENTS/SECURITY

A. The manufacturer's license agreements for software packages shall be made out to the Owner.

B. Contractor developed application programs shall become the property of the Owner at the conclusion of the Contract. There shall be no license agreements of any kind for these programs.

C. The Owner shall be provided with passwords required to access the PLC application programs and operator interface configuration data. There shall be no Contractor programmed security schemes that prevent access to the application programs or configuration data.

END OF SECTION

SECTION 13450

INSTRUMENTATION, CONTROL AND MONITORING SYSTEM TESTING REQUIRMENTS

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall test the Instrumentation, Control and Monitoring (ICM) System as specified herein to demonstrate compliance with the Contract Documents.

B. Related Sections include but are not necessarily limited to
   1. Section 01300 – Submittals.
   2. Section 13000 – Instrumentation, Control and Monitoring System General Requirements.
   3. Section 13200 – Instrumentation, Control and Monitoring System Panels.
   4. Section 13300 – Instrumentation, Control and Monitoring System Components.
   5. Section 13400 – Instrumentation, Operator Workstations, Human Machine Interface Terminals, and programmable Logic Controllers.

1.02 SUBMITTALS

A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests, in accordance with the requirements of Section 01300 - Submittals. The test plan shall contain the following at a minimum:
   1. A schedule of all testing to be conducted.
   2. A brief description of the testing to be performed.
   3. Test objectives.
   4. Testing criteria per the Specifications.
   5. Check lists and procedures for performing each of the specified tests.
   6. Sample test result documentation.
   7. Requirements for other parties.

1.03 INSTRUMENTATION, CONTROL AND MONITORING SYSTEM TESTING - GENERAL

A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously accepted by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have the Engineer or the Owner in attendance.

B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.

C. The Contractor shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be accepted prior to initiation of that testing, as specified hereinabove.

D. All test data shall be recorded on test forms, previously accepted by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.

E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

1.04 INSTRUMENTATION, CONTROL AND MONITORING SYSTEM FACTORY ACCEPTANCE TEST

A. The Instrumentation, Control and Monitoring System equipment shall not be shipped until the Contractor receives written notice of acceptability of the factory tests.

B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be accepeted in writing by the Engineer.

C. Each subsystem shall be fully factory tested for function and operation. As a minimum, all tests shall conform to "Hardware Testing of Digital Process Computers", recommended practice RP55.1. Instrument Society of America.

D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.

E. The contractor shall perform a 100-hour full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract Documents. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.

F. The factory testing shall demonstrate all aspects of system sizing and timing including:
   1. Monitoring and control scan times at the PLC level.
   2. Response times at the operator workstation level.

G. The overall system shall be tested at maximum and minimum input power voltage variation. Noise shall be imposed on the lines connected to the equipment to demonstrate that the units can operate in a noisy environment.

H. Operator Workstation Operation - This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:

1. Run all manufacturer's diagnostics (CPUs, disks, CRTs, etc.), to prove reliable subsystem operation. In the case of the CPU, this shall include hardware diagnostics, as well as demonstration of the manufacturer's system software (operating system, communications, database, etc.).
2. Demonstrate proper operation, under both normal and abnormal conditions of the operator workstation application software (SCADA, remote alarm dial-up, etc.). This shall include demonstration of system on-line diagnostics, fail-over features, reconfiguration operations, system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.
3. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.
4. Demonstrate the configuration of the system to verify conformance with the Contract Documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.
5. The system shall be operated with data input/output with the PLC's and associated panels to prove operation of all workstation functions.
6. The testing in Paragraphs 3 and 4 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously.

I. PLC Operation - All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLC's. This shall include the following:

1. On-line and off-line diagnostics.
2. For redundant units, fail-over operation and reconfiguration.
3. System initialization and restart.
4. Peer-to-peer communications.
5. Non-volatility of memory.
6. Operation of the control logic shall be demonstrated as described herein.

J. Process I/O Simulation - Process input/output simulation for PLC's shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process I/O systems such as plug-in circuit cards or I/O test modules may be utilized subject to acceptance by the Engineer to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:

1. To provide a means of communications checkout from the operator work stations through the various levels of software in the PLC's and to the process, i.e., the

simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.

2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.
3. To provide data for use at all levels of the control system at the time of system integration.

K. Control Strategy Testing - Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

1.05 INSTUMENTATION AND CONTROL SYSTEM FIELD TESTING

A. General Requirements
1. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
a. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified herein.
b. Each final control element shall be individually tested as specified hereinafter.
c. Each control loop shall be tested as specified hereinafter.
d. Each control strategy shall be tested under automatic digital control as specified hereinafter.
e. The entire control system shall be tested for overall monitoring, control, communications, and information management functions, and demonstrated for system availability as specified hereinafter.
2. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.
3. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and accepted prior to the next phase being started. Specific exceptions are allowed if written acceptance has been obtained in advance from the Engineer.

B. Contractor’s Responsibilities
1. The Contractor shall ensure that all equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
2. The Contractor shall be responsible for coordination of test meetings. A meeting shall be held each morning to review the day's test schedule with all participants. Similarly, a

meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.

3. The Contractor shall ensure that the electrical Work conforms with the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between other equipment and the control system specified herein.
4. The Contractor shall ensure that the HVAC Work conforms with the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.
5. The Contractor shall coordinate the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished under Division 16 and the control system specified herein.
6. The Contractor shall coordinate the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

C. Final Control Element Testing

1. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.
2. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD’s, that require turndown limits shall be initially set during this test.
3. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

D. Loop Checkout

1. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.
2. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written acceptance by the Engineer. All modes of control shall be exercised and checked for proper operation.
3. The accuracy of all Digital to Analog Conversions (DACs) shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.
4. The accuracy of all Analog to Digital Conversions (ADCs) shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.

5. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

E. Control System Startup and Testing

1. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.
2. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.
3. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.
4. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written acceptance by the Engineer.
5. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.
6. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Monitoring System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.
7. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.
8. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

F. Facility Startup Coordination

1. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Monitoring System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.
2. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.

3. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.
4. At least one qualified control systems technician shall be provided for control system startup and test activities (at least two when loop checkout is being performed).

1.06 INSTRUMENTATION, CONTROL AND MONITORING SYSTEM FINAL ACCEPTANCE TEST

A. Upon completion of all control system startup activities and prior to final system acceptance, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail-over, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. The Emgomeer shall be given two (2) weeks notice of the starting date of the 30-day availability test.

B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.
   1. Downtime of any data highway connected device that is automatically backed-up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.
   2. Downtime of a PLC that is not automatically backed-up shall be considered a system failure if the downtime of the failed controller exceeds one (1) hour.
   3. Downtime of a portion of the system resulting from failure of any field sensor shall not be considered a system failure provided that the system operates as specified under this condition.
   4. Downtime of the following devices shall not be considered a system failure provided the failed device is repaired within the specified time:
      a. Floppy disc memory (three days)
      b. Hard disc and moving head memory (one day)
      c. Workstations, excluding the floppy disc (one day)
      d. Communications interfaces (eight hours)
      e. Printer (three days)
      f. Data Highway LAN (eight hours)
      g. Magnetic tape and optical storage units (one day)
      h. UPS Unit (one day)
   5. Total shutdown of a single PLC resulting from a software fault shall be considered a system failure.
   6. An erroneous command to the process that can be specifically related to a software fault shall be considered as one (1) hour of downtime.
   7. The inoperability of any subsystem resulting from a software fault shall be considered a system failure.
   8. The failure of the same component more than one time during the 30-day test shall be considered a system failure.

C. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored.

D. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 13660
SURGE PROTECTION
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SECTION 13660
SURGE PROTECTION

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Comprehensive surge protection for all instrumentation devices supplied as part of these Specifications.

1.2 SUBMITTALS

A. Submit detailed product data.

1.3 QUALITY ASSURANCE

A. It is the responsibility of the System Manufacturer to provide appropriate protection against transients and surges for all field instruments, field wiring, and devices interfacing with control panels including but not limited to:

1. All instrument signal wiring, control wiring, telephone wiring and data transmission wiring which enters or exits buildings shall be protected against lightning spikes, and other transient surges at all control panel termination points.
2. All instrument signal wiring, control wiring, telephone wiring and data transmission wiring which terminates in outdoor control panels shall be protected against lightning spikes, and other transient surges at all control panel termination points.
3. All AC control power wiring shall be protected against lightning spikes, and other transient surges at all control panel termination points. Lightning and surge devices shall protect the system from induced surges in analog, discrete and control circuitry and power supply lines.

B. The protective devices shall not interfere with the normal operation of the panel hardware and shall be designed not to have a maximum clamping voltage in excess of what the protected device is capable of withstanding.

C. All field instruments located indoors or outdoors provided by the System Manufacturer under this contract shall be supplied with surge protection for 120 VAC power to the instrument.

D. Surge protectors shall include a combination of surge suppression technologies including, metal oxide varistors, gas discharge tubes, diodes, and 3AG size fuses for line-to-line and line-to-ground protection.

E. Surge protectors in controls panels shall be DIN rail-mounted with plug-in modules.

F. Where the length of the wire or cable with surge protection is greater than 90 feet, provide surge protection on each end.

G. All surge and lightning protection shall have UL or FM approval. System Manufacturer shall verify approvals.

PART 2. PRODUCTS

2.1 EQUIPMENT

A. Field Instruments - Analog Signals

1. Direct mounted surge protectors for analog signals shall screw directly into the unused conduit entry hub of the instrument. The surge protector housing shall be 304 stainless steel minimum. Surge protectors shall be specifically manufactured for protecting field instruments.

2. Where direct mount is not possible, the surge protectors for analog signals shall be located as close to the field instrument as practical. The surge protector shall be rated NEMA 4X, or shall be mounted in a stainless steel NEMA 4X enclosure.

B. Field Instruments - Discrete Signals

1. Surge protectors for discrete signals wiring shall be located as close to the field instrument as practical. The surge protector shall be NEMA 4X, or shall be mounted in a 304 stainless steel NEMA 4X enclosure.

C. Control Panels

1. All instrument analog and discrete signal wiring, data transmission wiring and 120 VAC power supply wiring which enters or exits buildings or which terminates in outdoor control panels shall be individually protected against lightning spikes, and other transient surges at all control panel termination points.

2. Provide surge protectors for all power wiring to control panels whether located indoors or outdoors.

D. Instrument Power Wiring

1. Provide surge protectors for all power wiring to individual instrument devices whether located indoors or out-of-doors. For instrument devices, protection shall be located as close to the device as practical. The surge protector shall be NEMA 4X, or shall be mounted in a NEMA 4X enclosure. Enclosures shall be NEMA 4X, stainless steel.

E. Miscellaneous Digital Equipment

1. Provide surge protection for SCADA panel and other miscellaneous digital hardware to include communications wiring and 120 VAC power supply wiring for each device.

2.2 ACCESSORIES

A. Spare Parts

1. Provide 10 percent spare surge protectors of each type used with a minimum of 5 of each type used.

2.3 SOURCE QUALITY CONTROL

A. Acceptable Products

1. Surge protection shall be equal to the following (or their latest offerings):

Surge Protector Acceptable Model Numbers		
	Telematic	Phoenix Contact
Field Instrument Analog Signals Direct Mounted	TP48	S-PT1-2PE-24VDC
Field Instrument Analog Signals Remote Mounted	SD Series	UFBK-M2-PE Series
Analog Signals Control Panel	SD Series	UFBK-M2-PE Series
120 VAC Power Control Panel	MA Series	UAK2-PE/S Series
Discrete lnputs/Outputs Control Panel	SD Series	UFBK-2/2 Series
RS-232	NP Series	MT Series, D-UFB Series
RS-485	NP Series	MT Series, D-UFB Series
Telephone Line	DP200 Series	TELETRAB-4X Series
Ethernet	NP Series	D-ETH Series
Antenna Cable	CA Series	COAXTRAB Series

2. Protection on 120 VAC power circuits may be also by Isolatrol (Model “Elite”).

PART 3. EXECUTION

3.1 INSTALLATION

A. Install all surge protection equipment in strict accordance with manufacturer’s guidelines.

B. For surge protectors located outdoors and for antenna surge protectors, surge protector grounding shall use individual ground rods located as close to the surge protector as possible. The grounding conductor shall be sized in accordance with manufacturer’s recommendations and be routed via the shortest path possible. Bends in the grounding conductor shall be avoided. If bends in the grounding

conductor are unavoidable then the number of bends shall be kept to an absolute minimum.

C. Provide installation for all field mounted surge protection equipment. Provide for all wiring terminations for surge protection equipment.

D. If a particular piece of equipment is protected by two surge protectors in series, ensure that the resulting equipment protection is not diminished.

END OF SECTION

SECTION 14650

JIB CRANES

PART 1 - GENERAL

1.01 SCOPE

A. Work included: Furnishing and installing free standing jib cranes, anchorage, and foundation.

B. Related Work:

1. Section 01600 - General Material and Equipment Requirements

2. Section 03300 - Cast-In-Place Concrete

3. Section 05500 - Miscellaneous Metals

1.02 REFERENCES

A. American Institute of Steel Construction (AISC) - Specification for Structural Joints Using High-Strength Bolts.

B. American National Standards Institute (ANSI): ANSI B30.11 - Monorails and Underhung Cranes.

C. ASTM International (ASTM):

1. ASTM A36 - Carbon Structural Steel.

2. ASTM F3125 – High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.

3. ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.

D. American Welding Society (AWS) D1.1 - Structural Welding Code.

E. Occupational Safety and Health Administration (OSHA) - Specification 1910.179 - Overhead and Gantry Cranes.

1.03 DESIGN REQUIREMENTS

A. Design Requirements:

1. Design jib crane, anchorage and foundation in accordance with the governing codes and design criteria as indicated on the Drawings and as specified herein.

2. Comply with the wind requirements of ASCE 7.

1.04 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Describe capacities, performance, operation, and applied forces to foundation.

2. Preparation instructions and recommendations.

3. Storage and handling requirements and recommendations.

4. Installation methods.

B. Shop Drawings: Shop drawings showing configuration, dimensions, service area, and construction and installation details.

C. Contract Closeout: Jib crane manufacturer shall provide the manufacturer’s Warranty prior to the contract closeout.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in designing and manufacturing cranes with 25 years successful experience.

B. Installer Qualifications: Company experienced in assembly and installation of cranes with 5 years successful experience and acceptable to crane manufacturer.

C. Perform welding by certified operators in accordance with AWS D14.1.

D. Bolted connections shall be in accordance with torque tightening procedures specified in AISC Specification.

E. Clearly label crane with rated load capacity. Place label at height and location easily read from floor level and loading position.

1.06 PRODUCT HANDLING

A. All materials shall be delivered in manufacturer’s original packaging.

B. Store materials in a dry, protected, well-vented area. The contractor shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.

C. Remove protective wrapping immediately after installation.

1.07 SUBSTITUTIONS

A. Proposals for substitution products shall be accepted only from bidding contractors and not less than (10) working days before bid due date. Contractor guarantees that proposed substitution shall meet the performance and quality standards of this specification.

1.08 JOB CONDITIONS

A. Verify that other trades with related work are complete before installing jib crane.

B. Mounting surfaces shall be straight and secure; substrates shall be of proper width.

C. Refer to the construction documents, shop drawings, and manufacturer's installation instructions.

D. Do not install products under environmental conditions outside manufacturer's recommended limits.

E. Observe all appropriate OSHA safety guidelines for this work.

1.09 WARRANTY/GUARANTEE

A. Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace assemblies and components that fail in materials and workmanship within warranty period from date of Substantial Completion. 5 years or 10,000 hours warranty for jib crane to cover defects in materials and workmanship. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Gorbel, Inc.

B. Or a pre-approved equal.

2.02 JIB CRANES

A. Performance:

1. Crane shall be designed, fabricated, and installed in accordance with ANSI B30.11 and OSHA 1910-179.

2. Crane shall be designed for minimum effort manual rotation.

3. Boom shall not drift when at rest.

4. Maximum deflection at boom end: 1/150 span based on capacity plus 15 percent for hoist and trolley weight.

5. Crane shall be designed to withstand the following:

   a. Live load capacity equal to net rated hook load: 1 ton.

   b. Base crane structural design on live load capacity plus 15 percent for hoist and trolley weight and 25 percent for impact.

B. Free Standing Jib Crane: Crane shall consist of mast requiring foundation support and a 360 degree rotating boom. Provide rotating collector assembly with service entrance and festoon service support as indicated.

1. Acceptable Manufacturer and Model: Model No. FS300 as manufactured by Gorbel, Inc.: Base plate mounted crane.

2. Base plate mounting: Provide hexagonal steel base plate welded to mast for anchoring crane to concrete foundation cast flush with floor slab.

3. Construction: Fabricate from ASTM A36 steel sections with finished ends and surfaces.

4. Mast: Stationary steel pipe, perpendicular to boom. Equip mast top with plate and pivot pin to receive head assembly.

5. Boom: Horizontal, wide flange steel beam bolted to head assembly and designed for hoist trolley traveling on bottom flange. Reinforce with cap channel as required for lateral stability. Equip boom with stops to limit movement of trolley.

6. Head assembly: Welded steel plate and channel fabrication fitted over mast, bolted to boom, and designed to transfer boom load to mast and to rotate. Assembly shall allow for installation of head prior to boom attachment and provide maximum hoist lift.

   a. Top pivot bearing assembly: Designed to connect head assembly to

mast and transfer load from boom. Weight bearing channel connecting sides of head assembly shall contain tapered roller bearings allowing easy rotation.

b. Retaining pin: Inserted through mast pivot pin above weight bearing channel to prevent accidentally dislodging head assembly. Cranes without retaining pin are not acceptable.

c. Trunnion roller assembly: Designed to rotate around mast and transmit moment force from boom to mast. Provide trunnion rollers with tapered bearings held in steel channel with 1 inch (25 mm) diameter bolts. Masts less than 18 inches (457 mm) diameter shall have 2 rollers and larger masts shall have 4 rollers. Assembly shall rotate around mast with full roller face contact. Roller surface shall be sufficiently large to prevent cutting into mast. Cranes with small rollers or cams requiring wear band on mast are not acceptable.

2.03 TROLLEY AND HOIST

A. Columbus McKinnon (CM) Lodestar Electric Chain Hoist Model L or pre-approved equal. Capacity shall match jib crane capacity.

2.04 ANCHORAGE

A. As required by jib crane.

B. Designed by Contractor’s qualified professional engineer, who is a civil or structural engineer registered in the in the State of Georgia.

C. Refer to Section 05500 - Miscellaneous Metals.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin installation until support structures have been properly prepared.

B. Design and construction of reinforced concrete footings and slabs as detailed on Drawings and specified in other sections. Verify that accurate crane applied forces and anchor bolt patterns are provided for foundation design.

3.02 INSTALLATION

A. Install units and accessories in accordance with manufacturer's instructions and approved shop drawings. Do not modify crane components in any manner without advance written approval by crane manufacturer.

B. Clearances for Moving Crane Components:

1. 3 inches (76 mm) minimum vertical clearance from any overhead obstruction.

2. 2 inches (51 mm) minimum horizontal clearance from any lateral obstruction.

3. Prior to applying proper torque to the bolts, ensure runways are:

a. Level to within plus or minus 1/8 inch in 20 feet (3 mm in 6.1 m).

b. Parallel with opposite runway to within plus or minus (3 mm in 6.1 m).

3.03 FIELD QUALITY CONTROL

A. Perform field quality control testing as recommended by manufacturer. Move bridge and hoist trolley through entire travel to ensure crane is clear of obstructions and moves freely and smoothly. Inspect installed crane. Verify all bolts are tight and lock washers fully compressed.

B. Field test crane and accessories for operating functions. Ensure crane movement is smooth and proper. Adjust as required and correct deficiencies.

C. Clean surfaces. If necessary, touch-up paint damage, scratches, and blemishes with manufacturer provided matching paint. Protect crane from other construction operations.

3.04 DEMONSTRATION AND TRAINING

A. Provide demonstration and training session for Owner's representative covering operation and maintenance.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

A. The work described in this Section and/or indicated on the Drawings shall include, except where otherwise noted, the furnishing of all materials, equipment, appurtenances, accessories, connections, labor, etc. required and/or necessary to completely install, clean, inspect, adjust, test, balance and leave in safe and proper operating condition all mechanical (HVAC and plumbing) systems.

B. Prior to the ordering or purchase of any equipment or materials or the layout or installation of any work, the Contractor shall visit and examine the site and shall examine and understand the work shown on the Drawings and described in these Specifications. If any work involves existing equipment, ductwork, piping, buildings, etc., the Contractor shall first verify model numbers, electrical characteristics, sizes, dimensions, etc. to be compatible with the work shown on the Drawings.

C. Throughout the course of the Project, the Contractor shall schedule and coordinate work with the Engineer and other trades to optimize space utilization and avoid conflict or interference with the work of other trades, structural elements, doors, windows, lights, conduit and other equipment or systems.

D. Unless otherwise shown on the Electrical Drawings, the mechanical work shall include the following items. These items shall conform with the requirements of Division 16.

1. All motors, motor starters, disconnect switches, relays and other controls and control wiring necessary for the proper operation of all mechanical equipment shall be furnished and installed under Division 15. Power wiring to mechanical equipment and a 120-volt source for control power shall be provided as a part of the electrical work.

2. All controls and control wiring shall be provided and installed under Division 15. Where control power is not available in the vicinity of mechanical equipment, a transformer shall be furnished and installed to convert power voltage to control voltage. The transformer may be an integral part of the starter.

3. Starters complete with "hand/off-/automatic" switches, with running indication lights in an approved enclosure, shall be furnished- and installed for mechanical equipment automatically started and stopped, or otherwise

controlled by thermostats, timers, or other devices under Division 15. Starters for all manually controlled equipment shall include start/stop pushbuttons with running indication- lights in an approved enclosure.

E. All electrical items provided under Division 15 of the Specifications shall be provided in accordance with applicable sections of Division 16. Enclosures shall be the same NEMA type as specified in Division 16 or on the Electrical Drawings.

F. The Contractor will be held responsible for the satisfactory and complete execution of all work included. The Contractor shall produce complete finished operating systems and provide all incidental items required as part of the work, regardless of whether such item is particularly specified or indicated.

1.02 QUALITY ASSURANCE

A. Codes and Standards

1. All mechanical work shall be performed in accordance with all applicable codes, ordinances, rules and regulations of local, state, federal or other authorities having jurisdiction. As a minimum, this shall include:

    a. International Building Code 2018 with Georgia Amendments.
    b. International Mechanical Code 2018 with Georgia Amendments.
    c. International Energy Conservation Code 2015 with Georgia Amendments.
    d. International Plumbing Code 201 with Georgia Amendments.
    e. International Fire Code 2018 with Georgia Amendments.
    f. National Fire Protection Association Codes.
    g. National Electric Code 2023
    h. Unless otherwise specified on the Drawings, the latest edition of all codes, ordinances, etc. shall be followed. Where code or other requirements exceed the provisions shown on the Contract Documents, the Contractor shall notify the Engineer. Where provisions of the Contract Documents exceed code or other requirements, the Work shall be performed in accordance with the Contract Documents.

2. All equipment, products and materials used in mechanical work shall be listed by Underwriters Laboratories, ARI or AMCA as appropriate.

3. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Engineer.

B. Allowable Tolerances: Equipment shall be readily adaptable for installation and operation in the structures shown on the Drawings. No responsibility for

alteration of a planned structure to accommodate other types of equipment will be assumed by the city. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All such alterations shall be made at the Contractor's expense.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. Drawings and Specifications:

1. The Drawings are diagrammatic and, unless specifically dimensioned, are intended to show only the general arrangement of equipment and accessories, and the general routing of piping, ductwork, etc. The Drawings do not specifically show every fitting, offset, contour, etc. required to accomplish the intended work or to avoid every interference that may be encountered. It shall be the responsibility of the Contractor to arrange all work to fit within the allowed space without modifying any building structure or property, and to make readily accessible all equipment and accessories requiring servicing or maintenance.

2. Should any changes be deemed necessary by the Contractor in items shown on the Contract Drawings, the Contractor shall submit shop drawings, descriptions, and the reason for the proposed changes to the Engineer for approval.

3. Exceptions and inconsistencies in Drawings and Specifications shall be brought to the Engineer's attention before Bids are submitted.

C. Operation and Maintenance Instructions: Operation and maintenance instructions shall be provided in accordance with the requirements of the General Conditions of the Contract Documents. The Contractor shall instruct the City's personnel during the adjustment and testing period. The Contractor shall also, in the presence of the Engineer, demonstrate the complete operation of each and every piece of apparatus.

1.04 QUALITY STANDARDS

A. All materials shall be furnished by manufacturers fully experienced, reputable and qualified in the manufacture of the particular material to be furnished. All material shall be designed, constructed and installed in accordance with standard practices and methods and shall comply with these Specifications as applicable.

B. The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these Specifications.

1.05 TRANSPORTATION AND DELIVERY

A. As part of the mechanical work, the Contractor shall provide and pay for all transportation, delivery and storage required for all equipment and materials.

B. The Contractor shall closely coordinate the ordering and delivery of all mechanical equipment with other trades to assure that equipment will be delivered in time to be installed in the building without requiring special or temporary access or building modifications. Certain equipment may have to be installed prior to the erection of the building walls or roofs.

1.06 STORAGE AND PROTECTION

A. Equipment and materials shall be properly stored to protect against vandalism, theft, the elements and other harm or damage. Any equipment or materials received in a damaged condition, or damaged after receipt, shall not be installed. Only new undamaged equipment in first-class operating condition shall be installed.

B. Provide protection covers, skids, plugs or caps to protect equipment and materials stored or otherwise exposed during construction.

1.07 WARRANTY

A. All mechanical work described in the Contract Documents shall be warranted in accordance with the General Conditions of the Contract Documents.

B. This warranty shall apply to all equipment, materials and workmanship.

C. During the warranty period, all defects in mechanical systems shall be corrected in an acceptable manner, consistent with the quality of materials and workmanship of original construction, at no expense to the City.

PART 2 - PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be new, of the best grade and quality and of current production, unless specified otherwise. Equipment not specified in the Contract

Documents shall be suitable for the intended use and shall be subject to approval by the Engineer.

2. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage or wear.

3. Electric motors shall be as specified in Section 16150, Electric Motors, unless otherwise specified.

B. Piping: See appropriate sections of Division 15 for Specifications on various piping systems. See Part 3 of this Section for general stipulations on installation of piping systems.

C. Valves: See appropriate sections of Division 15 for Specifications and Part 3 of this Section for general stipulations on valve installation.

D. Unions

1. Provide and install unions between each item of equipment and the valve controlling and/or the various piping connections to it.
    a. Steel Pipe: Unions 2-1/2-inches and smaller shall have ground joints. Unions 3-inches and larger shall have flanged unions.
    b. PVC Pipe: Unions 2-inches and smaller shall be threaded and have Buna O-rings. Unions 2-1/2-inches and larger shall be flanged.

E. Equipment Bases: Each piece of equipment which is motor driven shall be furnished with an approved base, which shall be in addition to the foundation. Each base shall be furnished integral with the equipment or apparatus, or shall be furnished as a separate item, designed to accommodate the equipment or apparatus. Submit shop drawings for all foundations and supports for review.

F. Dielectric Isolation

1. Wherever dissimilar metals are used in piping systems, this connection shall be made with dielectric isolators. The dielectric isolators shall be so designed that non-ferrous piping materials shall be isolated by the use of Teflon or nylon isolating materials made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection. All dielectric isolators shall be selected for the pressure and contents of the system involved.

2. Dielectric isolators shall be Watts, Epco, Crane, Maloney, or Equal.

G. Anchor Bolts

1. All anchor bolts shall be ANSI type 316 stainless steel and must conform to requirements of Section 01600 and the material articles in the appropriate Sections in which they are used.

2. All anchor bolts are to be supplied by the manufacturer or fabricator of the specific material or equipment to be installed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be installed according to the manufacturer's recommendations and in accordance with the best practice and standards for the work.

2. All work shall be performed by competent personnel satisfactory to the Engineer. All work requiring particular skill shall be performed by persons that have had special training and past experience in that line of work.

B. Equipment Support

1. Major equipment supports (concrete foundations, framed structural openings, etc.) shall be furnished and installed under other Divisions of the Contract Documents as shown on the Drawings. The mechanical work shall include, however, the furnishing and installation of all miscellaneous equipment supports, housekeeping pads, structural members, rods, clamps and hangers required to provide adequate support of all mechanical equipment.

2. Unless otherwise shown on the Drawings, all mechanical equipment, piping and accessories shall be installed level, square and plumb.

C. Pipe and Ductwork Penetrations

1. Sleeves or wall pipes shall be installed in all masonry or concrete walls, floors, roofs, etc. for pipe and ductwork penetrations. Sleeves for ductwork shall be 20-gauge galvanized steel. Sleeves shall be sized to provide a minimum of ¼-inch clearance between the sleeve and pipe or duct. For insulated pipes or ducts, the clearance shall be ¼-inch between the sleeve and the insulation.

2. As far as possible, all pipe and ductwork penetrations shall be made at the time of masonry or concrete construction. Where drilling is required, only

core drills shall be used. Star drills shall not be used.

D. Welding

1. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. Refer to section 15060 for welding requirements for filter backwash air piping.

2. All welding operations shall conform to the latest recommendations of the American Welding Society or to the applicable provisions of the Code for Pressure Piping. The Contractor shall pay for all electrical energy and/or gas used in welding.

E. Cutting and Patching: Where cutting or patching becomes necessary to permit the installation of any work or should it become necessary to repair any defects that may appear in patching, the Contractor shall make the necessary repair at no cost to the City.

F. Large Apparatus and Equipment: All large apparatus and equipment which is specified or shown to be furnished or installed under this Contract, and which may be too large to be moved into its final position through the normal building openings planned, shall be placed by the Contractor in its approximate final position before any obstructing structure is installed. All apparatus shall be cribbed up from the floor and cared for as specified under Paragraph 1.06 or as directed by the Engineer.

G. Cross Connection and Interconnections

1. No plumbing fixture, device or piping shall be installed which will provide a cross connection or interconnection between a distributing supply for drinking or domestic purposes and a polluted supply, such as drainage system or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water or waste into the water supply system.

2. The Contractor shall verify location of all existing utilities and make all connections to existing facilities as required.

H. Thermal Expansion of Piping

1. The Contractor shall furnish and install all devices required to permit the expansion and contraction of all work installed by the Contractor, particularly in water supply and circulating systems. In the main water and circulating lines, Contractor shall employ expansion joints where required or directed by the Engineer. Swing joints, turns, expansion loops or long offsets shall be provided wherever shown on the Drawings or wherever necessary to allow for the expansion of piping within the building. Broken pipes or fittings broken due to rigid connections must be removed and

replaced at the Contractor's expense.

2. Anchor all lines having expansion joints so that expansion and contraction effect is equally distributed. Verify exact locations of anchors with the Engineer prior to making installation. The lines having expansion joints shall be accurately guided on both sides of each joint. These guides shall consist of saddles and "U" clamps properly arranged and supported. Submit complete details for approval.

3. In installing expansion members, exercise care to preserve proper pitch on lines. Furnish and install all special fittings, connectors, etc., as required.

3.02 SURFACE PREPARATION, SHOP AND FIELD PAINTING

A. Unless otherwise specified herein or shown on the Drawings, general painting of mechanical equipment shall be in accordance with Division 9.

B. Touchup painting of mechanical equipment shall be part of the mechanical work. All equipment and materials that are painted or coated by the manufacturer shall be -touched up prior to completion to conceal any and all scratches or other finish irregularities and to maintain the integrity of the paint or coating. -All painting and coating shall match the original and shall conform to the requirements detailed in other sections of these specifications.

C. All roof mounted equipment shall be painted with an exterior paint of a type and color as- specified in Division 9. The painting shall not impair the performance of the equipment in any manner.

3.03 INSPECTION AND TESTING

A. The mechanical work shall include all materials and labor required to properly test and balance all mechanical systems as required by codes and as described herein.

B. Concealed, underground and insulated piping shall be tested in place before concealing, burying or covering. Tests shall be conducted in the presence of the Engineer or designated representative. Equipment, materials and instruments required for tests shall be furnished without incurring additions to the Contract. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Engineer.

C. Unless otherwise specified herein all mechanical piping shall be tested as required by Code to 11/2 times the rated system pressure or 100 -psig (modify as needed), whichever is greater. Care shall be taken to isolate all equipment not suitable for this test pressure by installing pipe caps or blank flanges at the equipment connections. All valves and fittings shall be tested under pressure.

Refer to section 15060 for pressure testing requirements for filter backwash air piping.

D. Soil, waste and vent piping shall be tested with water before installing fixtures. Water test shall be applied to the system either in its entirety or in sections. If the test is applied to the entire system, all openings in the piping shall be closed except to highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening except the highest opening of the section under test shall be plugged and each section shall be filled with water and tested with at least a 10 foot head of water. Each joint or pipe in the building except the uppermost 10 feet of the system shall be submitted to a test with at least a 10 foot head of water. The water shall be kept in the system, or in the portion under test, for at least 1 hour before the inspection starts; no substantial drop in the water level will be acceptable.

E. The services of an independent testing and balancing agency shall be used to balance the air and water distribution systems.

3.04 CLEANING

A. At all times, the premises shall be kept reasonably clean and free of undue amounts of waste, trash and debris by periodic cleaning and removal. After completion, all foreign material, trash and other debris shall be removed from the site.

B. After all equipment has been installed, but prior to testing and balancing, all equipment, piping, ductwork, etc. shall be thoroughly cleaned both inside and out.

C. All air moving equipment operated during construction shall have filters in place and changed regularly so as to be clean.

D. After testing and balancing and just prior to Engineer review and acceptance, all systems shall be finally cleaned and shall be left ready for use. Air filters shall be new and piping strainers shall be clean.

E. All water piping shall be cleaned and disinfected in accordance with Section 15060 of these specifications.

END OF SECTION 15050

SECTION 15056
PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Design and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles

B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.

C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.

D. Pipe support locations and types for piping ½ in. and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports ½ in. and larger pipe support shop drawings together with a marked-up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.

   The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified in paragraph 2.03 J.

E. Design and provide all temporary pipe supports required during installation and testing.

1.02 RELATED WORK

A. Division 1: General Requirements

B. Section 03300: Cast-in-Place Concrete

C. Section 09900: Painting

D. Section 15060: Piping and Appurtenances

E. Section 15100: Valves and Appurtenances

F. Section 15400: Plumbing

G. Section 15891: Ductwork

1.03 REFERENCES

A. American Institute of Steel Construction (AISC) Manual of Steel Construction.

B. American Society for Testing and Materials (ASTM) Publications:

1. A36: Specification for Structural Steel.
2. A500: Cold formed welded and seamless carbon steel structural tubing.
3. E165: Practice for Liquid Penetrant Inspection Method.
4. E709: Practice for Magnetic Particle Examination.
5. A307: Specification for Carbon Steel Bolts and studs, 60,000 psi Tensile.
6. A312: Seamless and welded austenic stainless steel pipe.
7. A572: Specification for Steel Plate.

C. American National Standards Institute (ANSI):

1. ASME/ANSI B31.1: Power Piping Code.

D. American Welding Society (AWS) Code:

1. Structural Welding Code D1.1.

E. Manufacturers' Standardization Society (MSS):

1. MSS SP-58: Pipe Hangers and Supports - Materials and Design.

2. MSS SP-69: Pipe Hangers and Supports - Selection and Application.

3. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.

4. MSS SP-90: Guidelines on Terminology for Pipe Hangers and Supports

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

G. OSHA

1.04 SEISMIC DESIGN REQUIREMENTS

A. Conform to the requirements as indicated on the structural drawings and as specified herein.

B. It shall be the responsibility of the Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all pipe supports designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Design, certification signed by registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

1.05 SUBMITTALS

A. Shop Drawings: Submit the following in accordance with the General Conditions:

1. Pipe support drawings specified in paragraph 1.01 and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.

a. Detailed drawing of the device with dimensions.

b. A table of applied forces and moments.

c. A complete bill of materials.

d. A unique identification and revision level.

e. Stamp of a Registered Professional Engineer, registered in the State of Georgia, experienced in pipe support design and pipe stress analysis as specified in paragraph. 1.06 D.

f. Detailed connections to existing structure.

g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1-1.7.

2. Welding Procedure: Submit description as required to illustrate each welding procedure to be performed in the specified work.

3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.

4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.

5. Pipe support manufacturers' qualifications as specified in paragraph 1.06 D.
   a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.

   b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, whom stamps and seals shop drawings and designs.

6. Coordination drawings for pipe supports shall include as a minimum the following information.

   a. Coordination drawings shall include all pipe supports covered by specifications 15060, 15400 and 15891.
   b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation

c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.
d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4 inch scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-in. or less in diameter that will be field routed need not be shown on coordination drawings.
e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections as required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.
f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Owner for resolution.
g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.
h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the owner.

7. Written notification of any deviations from the requirements of this specification.

8. Support documentation and justification as specified.

9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports. See Section 01300 for form.

1.06 QUALITY ASSURANCE

A. Pipe support: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufacturer's

Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

B. Structural Concrete: Conform to the requirements of Section 03300. Concrete strength: 4,000 PSI unless noted otherwise.

C. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

D. Pipe Support Manufacturer Qualifications:

1. Must possess a written quality assurance program.
2. Have a minimum of five (5) years experience in the design and fabrication of pipe supports.
3. Have completed the design and fabrication of at least five (5) successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.
4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten (10) years' experience in the design of piping systems and pipe supports.
5. Manufacturers' Standardization Society (MSS) Member.
6. Have a field service technician on staff with at least five (5) years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

B. Receiving:

1. Inspection and inventory items upon delivery to site.

2. Store and safeguard material in accordance with manufacturers' written instructions.

1.08 SPECIAL REQUIREMENTS

A. Refer to applicable specification sections of Division 1 and provide the following.

1. Foundations, Installations and Grouting.

2. Bolts, Anchor Bolts, and Nuts.

3. Sleeves and inserts.

4. Protection against electrolysis.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Carpenter & Paterson.

B. ITT Grinnell Corporation.

C. Empire Industries Inc.

D. Or equal.

2.02 MATERIALS:

A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all stainless-steel piping. Copper plated pipe supports are not acceptable.

B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.

C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.

D. Provide only new material. Previously used and/or scrap material is not acceptable.

E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, platesbA-572 or equal.

F. Provide sliding Teflon plates as required. The sliding surfaces shall be a nominal 3/8 in. glass filled Teflon bonded to stainless steel backup plate with a 10-gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Con-Slide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc. or acceptable equivalent product.

G. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:

1. Tensile strength - 2,000 psi

2. Elongation - 225%

3. Specific Gravity - 2.17 to 2.22

4. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi.

5. The compressive creep shall be a minimum of 2% at 2,000 psi and 70 degrees F.
6. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer's plant.

H. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.

2.03 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS

A. Design and provide pipe supports for piping ½ in. and larger to include the following loads:

a. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load as required), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.

b. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.

c. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.

B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.

C. Where possible, provide pipe supports, which are the manufacturers' standard products.

1. Provide pipe supports with individual means of adjustment for alignment.

2. Furnish pipe supports complete with appurtenances including locking and adjusting nuts.

3. Hanger rods shall be subjected to tension only.

4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.
5. Provide concrete inserts capable of supporting the design loads.

6. Metal framing systems will be acceptable to support piping 2 in. and smaller.

7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16-gauge shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 in. in length.

8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.

9. Provide supplementary steel as needed.

10. Do not support pipes from other pipe, conduits or metal stairs.

11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.

12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.

13. All pipe supports located in fluid flow shall be supplied with double nutting.

D. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping and designed in accordance with governing codes.

E. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

F. Pipe supports connected to structural framing and slabs are subject to the following limitations:
   1. Less than 100 lb horizontal load per support.

   2. Vertical loads not to exceed an average of 25 P.S.F. for slabs, with a maximum vertical load per hanger of 1000 lbs.

   3. For a maximum of one pipe support per foot of slab width perpendicular to the span.

   4. Vertical loads not to exceed 3,000 lbs. per column or 3,000 lbs. per support at walls.

   5. Piping not supported from floors by metal framing must meet the limitations as specified above.

G. All outside above ground supports shall be Type 316L stainless steel as specified in paragraph 2.02(C).

H. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.

I. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.04 FABRICATION

A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.

B. Providing welding in accordance with Structural Welding Code.

C. Provide dimensional tolerances as specified in MSS-SP-89.

D. Provide threading and tapping in accordance with MSS-SP-89.

2.05 SHOP PAINTING

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces. Refer to Section 09900 for coating requirements.

B. Color: As specified for piping system of same service or as selected by the Engineer.

C. Provide similar additional paint for touch-up after installation.

D. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer's printed instructions.

E. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

PART 3 - EXECUTION

3.01 GENERAL

A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.

B. Perform welding in accordance with Structural Welding Code:

1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check

inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of grove welds for throat opening and for snug positioning for back-up bars.

2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.

3. Magnetic Particle Inspection: Perform in accordance with ASTM E 709.

4. Liquid Penetrant Inspection: Perform in accordance with ASTM E 165.

5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.

6. Test Locations: As selected by the Owner. (Specify minimum of pipes per number of welds and welds linear footage.)

7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.

C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Section 03300.

D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.

F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or as required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement

based on expansion of 1 in/ 100 ft, for each 100 deg. F change in temperature exceed ½ in., provide sliding supports.

I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8 in. thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.

J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.

K. Apply an anti-seize compound to nuts and bolts on all pipe supports.

L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.02 INSTALLATION OF BUILDING ATTACHMENTS

A. Support piping from structural framing, unless otherwise indicated.

B. Concrete Inserts:

1. Use existing embedded concrete items whenever possible.

2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.03 THRUST ANCHORS AND GUIDES

A. Thrust Anchors:

1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.

2. Restraining rod size and number shall be as indicated and adhere to manufacturers' recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.04 PIPE SUPPORTS

A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.

B. Provide minimum of two pipe supports for each pipe piece unless approved by Engineer.

C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 in. out from face of wall and at least 3 in. below ceiling.

F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.

H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

J. Do not support piping from other piping.

K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

M. All rigid rod hangers shall provide a means of vertical adjustment after erection.

N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.

O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.

P. Hanger spacing shall not exceed the spacing listed below:

1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.
2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.

Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.

R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

S. All threads shall be UNC unless otherwise specified.

T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8 in. fillet weld, ½ in. long every 3 inches each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.

3.05 INSULATED PIPING

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where vapor barriers are indicated on water piping, install coated protective shields.

END OF SECTION 15056

SECTION 15060
PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, equipment and materials required to furnish, install and test, complete the plant piping including all fittings, sleeves, unions and accessories, as specified herein and/or shown on the Drawings. The materials to be used for piping systems are listed by service in the Piping Schedule hereinafter.

B. Contract drawings show only functional feature 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 considered as being included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Section 02200, Excavation and Backfill.

2. Section 09900, Painting.

1.02 SUBMITTALS

A. 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.

3. Drawings and engineering data on fabricated piping including locations of all piping supports, anchors, expansion joints, mechanical couplings and all other piping appurtenances.

B. Prior to its incorporation into the work, the Contractor shall submit to the Engineer written evidence that the pipe furnished under this Specification is in conformance with the material and mechanical requirements specified

herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test results from an independent testing laboratory on samples of pipe materials.

1.03 QUALITY ASSURANCE

A. 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 National Standards Institute (ANSI).

2. American Society for Testing Materials (ASTM).

1.04 QUALITY STANDARDS

A. All such work shall be done by competent workmen in a thorough professional manner according to the best practice and in compliance with all codes and applicable regulations, with proper provisions for uncoupling, draining, expansion and contraction.

B. See applicable sections of Part 2 - Products for Manufacturer quality standards.

1.05 STORAGE AND PROTECTION

A. All piping and tubing and accessories shall be stored above ground fully supported so as not to bend or deflect excessively under their own weight. Piping shall be stored with slope so as to be free draining.

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 MATERIALS

A. General

1. No broken, cracked, deformed, imperfectly coated or otherwise damaged or defective pipe or fittings shall be used. All such materials shall be removed from the site.

B. Stainless Steel Pipe, Tubing and Fittings

1. Stainless steel pipe, 3 inches and larger, shall be pickled and passivated, and shall conform to the requirements of ASTM A 778, Type 304L and 316L "as welded" grade. The minimum wall thickness shall be Schedule 10S.

2. Unless otherwise specified or shown, stainless steel pipe 2-½-inches and smaller shall be screwed: ASTM A312, Type 304 or 316, Schedule 40S.

3. Fittings 2-½-inch and smaller shall be screwed, stainless steel, 150-pound, rated 1,000-pound CWP, forgings conforming to ASTM A 182, Grade F304 or barstock to ASTM A 276, Type 304, dimensions conforming to ANSI B16.3.

4. Welded fittings 3-inch and larger shall be of the butt-welded type of pickled and passivated stainless steel matching the piping and conforming to ASTM A 774, Type 304L or 316L and ANSI B16.9. All ells shall be long radius type unless otherwise designated. Elbows 3-inches to 16 inches inclusive shall be smooth flow type. Elbows 18 inches and larger may be fabricated in mitered sections.

5. Branch connections 2-½-inch and smaller shall be screwed tees as specified under Paragraph Fittings, or 3,000-pound WOG forged stainless steel, ASTM A 182, Grade 304L or 316L, commercial welding branch fittings with threaded outlet, as manufactured by Bonney Forge Division, Gulf and Western Industrial Division, Allentown, PA; Allied Piping Products Co., Inc., Norristown, PA; or equal

6. Branch connections 2-inch and larger, including tees or reducing tees shall be as specified under Paragraph Fittings or fabricated from pipe.

7. Flanges shall be 150 pound, forged stainless steel conforming to

ASTM A 182, Grade 304 or 316 matching the pipe material and ANSI B16.5. Bolts shall be heavy hex conforming to ASTM A 193, Grade B8M, Type 316 stainless steel. Nuts shall be heavy hex conforming to ASTM A 194, Grade 8M, Type 316 stainless steel. When mating flange on valves or equipment is cast iron, use ASTM A 307, Grade B, square head bolts and ASTM A 563, Grade A heavy hex head nuts. Gaskets shall be red rubber 1/16-inch thick, conforming to ANSI B16.21.

8. Stainless steel tubing shall conform to ASTM A269, and shall be Type 316, seamless, and fully annealed. All tubing supplied shall be standard wall thickness for 200 psi maximum working pressure. Compression type stainless steel fittings shall conform to ASTM A182, with Grade F316 forged bodies or ASTM A276, Type 316 barstock bodies. All tubing fittings shall be flareless and Parker-Hannifin Ferulok or Flodar BA series; or equal.

C. Polyvinyl Chloride Pipe and Fittings (PVC pressure piping)

1. Polyvinyl Chloride Pipe shall be of unplasticized compounds suitable for use with chemicals and sewage, as shown on the Drawings and as specified and shall bear the seal of approval to this effect from an accredited testing laboratory. Pipe shall conform to the requirements of ASTM D1784 and D1785, Schedule 80, Type 1, Grade 1, or class 12454-B.
2. Fittings shall conform to the requirements of ASTM Designation D2467, Class 12454-B for socket type and ASTM Designation D2464 for threaded type.
3. Compounds for pipe and fittings shall conform to the requirements of ASTM Designation D1784, Class 12454-B.
4. Joints shall be the solvent-welded socket or flanged type. Flanges, where shown, shall be 150-pound, and shall be of the same material as the pipe.
5. Bolts for use with PVC flanges shall be as follows:

With Flat Ring Gaskets	Carbon steel, ASTM A307, Grade B square head bolts and ASTM A563, Grade A heavy hex head nuts
With Full Face Gaskets or in Corrosive Areas or Buried	Type 316 stainless steel, ASTM A193, Grade B8M hex head bolts and ASTM A194, Grade 8M hex head nuts

6. Gaskets shall be EPDM or Viton, full-faced.

7. All socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacturer and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Provide adequate ventilation when working with pipe joint solvent cement.

8. Provide magnetic tracer tape for all buried PVC piping.

D. Ductile Iron Pipe

1. Unless otherwise specified elsewhere, ductile iron pipe shall have a minimum wall thickness in accordance with Pressure Class 350, except for sizes 14" and larger, which shall have a minimum wall thickness in accordance with Pressure Class 250. All ductile iron pipe supplied shall conform to the requirements of ANSI/AWWA Specifications C150/A21.50-81 and C151/A21.51-1981.
2. Fittings in pipelines shall conform to the requirements of ANSI/AWWA C110/A21.10-82, Pressure Class 350 for 12” and smaller and Pressure Class 250 for 14” and larger sizes.

3. Ductile iron pipe and fittings furnished for water lines shall be cement lined Type II per ANSI Specification A21.4 (AWWA C104), unless otherwise indicated in the Piping Schedule. Ductile iron pipe and fittings furnished for sewer lines shall be ceramic epoxy.

4. Exposed joints shall be flanged or restrained mechanical joints unless otherwise shown on the Drawings. Buried joints shall be push-on or mechanical joints and shall conform to the following requirements:

Flanged	ANSI/AWWA C110 & ANSI B16.1, faced and drilled 125 lb ANSI Standard
Mechanical Joint	ANSI/AWWA C110, ANSI/AWWA C111 and ANSI/AWWA C151

Push-On	ANSI/AWWA C110, ANSI/AWWA C111 and ANSI/AWWA C151, American Cast Iron Pipe Company, or U.S. Pipe and Foundry Tyton joint, or equal

Restraining of joints shall be as recommended in the Cast Iron Pipe Research Association (CIPRA) Handbook of Cast Iron Pipe.

5. Mechanical joints with retainer glands are not acceptable.

6. Flanges shall be ductile iron, threaded, rated for 250 psi working pressure, and conform to ANSI A21.15/AWWA C115 and ANSI 125 lb drilling.

7. For Class 125 FF flanges, carbon steel, ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts shall be used. For mechanical joints, the manufacturer's standard shall be used.

8. Gaskets for mechanical or push on- joints shall be rubber, conforming to ANSI A21.11, AWWA C111. Gaskets for flanged joints shall be 1/8" thick, cloth inserted rubber conforming to applicable parts of ANSI B16.21 and AWWA C207. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in sewage or potable water lines. Gaskets shall be -full-face- type for 125 lb FF flanges.

E. Steel Pipe and Fittings

1. Steel pipe supplied shall be schedule 40 carbon steel, black, electric fusion welded or seamless conforming to the requirements of ASTM A 53, Grade B, with beveled ends. Pipe joints shall be butt-welded or flanged, as specified herein. Tees shall be ANSI B16.4 welding tees.

2. Butt-welded flanges shall be carbon steel, to match pipe wall thickness. Fittings shall be seamless conforming to ASTM A234 and ANSI B16.9. Use long radius elbow unless otherwise noted.

3. Flanges shall be 150 lb. forged steel, conforming to ASTM A181 and ANSI B16.5. Carbon steel, ASTM A 307, Grade A hex head bolts ASTM A 563, Grade A hex head nuts shall be used. Gaskets shall be 1/16" thick high-heat synthetic fluoropolymer, full-face type.

F. Copper and Copper Alloy Pipe, Tubing, and Fittings

1. Copper tubing shall be seamless, and conform to ASTM B88 (Type K and L)

2. Fittings shall be commercially pure wrought copper, socket joint, and conform to ASTM B75 and ANSI Bl6.22.

3. The solder used shall be 95 5 wire solder conforming to ASTM B32, Grade 95 TA. Do not use cored solder.

4. Piping fabrication and installation shall conform to the requirements of Chapter V of ANSI B3 1.3.

5. Bends in soft temper tubing shall be long sweep, wherever possible. Bends shall be shaped with bending tools and shall be made without appreciable flattening, buckling, or thinning of the tube wall at any point. Tubing shall be cut square and burrs removed. Inside of fittings and outside of tubing shall be cleaned with steel wool and muriatic acid before sweating. Take care to prevent annealing of fittings and hard drawn tubing when making connections. The qualification of brazing procedures, brazers, and brazing operators shall be in accordance with the requirements of Articles XII and XIII, Section IX, ASME Boiler and Pressure Vessel Code.

6. Buried service air type K copper piping shall be encased in concrete and concrete O.D. shall be 6-inches greater than pipe O.D.

G. Insulating Flanges, Couplings and Unions. Materials and ratings shall be in accordance with the applicable piping system as listed by service in the Piping Schedule. Dielectric flanges and unions shall be as distributed by Epco Sales, Inc., of Cleveland, OH; Capitol Insulation Unions; or equal. Insulating couplings shall be Dresser STAB-39; R. H. Baker Series 216; or equal.

H. Couplings

1. Flexible couplings, flanged coupling adapters, or expansion joints shall be provided for piping systems at connections to equipment and where shown. The Contractor may install additional flexible couplings to facilitate piping installation, provided that it submits complete details describing location, pipe supports, and hydraulic thrust protection.

2. Acceptable types of couplings for ductile iron pipe are as follows:

a. Flexible Couplings: Dresser Style 153 or equal, with zinc

plated bolts and -nuts. Thrust ties shall be provided to sustain the force developed by 1-½ times the test pressure specified.

b. Transition Couplings: Transition couplings used to connect pipes with small differences in outside diameter shall be Dresser Style 162, or equal.

c. Flanged Adapters:

1) Flanged coupling adapters shall be used for joining plain end cast iron or ductile iron pipe to flanged valves, pumps and fittings. Flanged adapters shall be suitable for working pressures to 150 psig.

2) Flanged coupling adapters in sizes 12" and smaller shall consist of an ASTM 126, Class B cast iron flanged body drilled to mate with a 125-pound cast iron flange per ANSI B16.1, a cast iron follower ring, a rubber compound, wedge section gasket, a sufficient number of track head and electroplated steel bolts to properly compress the gasket.

3) Flanged coupling adapters in sizes 12" and larger shall consist of a high strength steel, flanged body drilled to mate with a 125 lb cast iron flange per ANSI B16.1, a high strength steel follower ring, a rubber compound, wedge section gasket, a sufficient number of track head and electroplated steel bolts to properly compress the gasket.

4) Rubber gasket shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil and grease.

3. Acceptable types of couplings for steel pipe are as follows:

a. Flexible Couplings: Dresser Style 38, or equal. Thrust ties shall be as specified above for ductile iron pipe couplings.

b. Transition Couplings: Dresser Style 162, or equal.

c. Flanged Coupling Adapters: Dresser Style 128, or equal. Thrust restraint shall be as specified above for ductile iron flanged coupling adapters.

d. Flexible Connectors (Bellows Type): Bellows type flexible connectors shall be Style 1025 (double arched) manufactured by General Rubber Corporation, South Hackensack, NJ, or equal. Connectors shall be rated for a working pressure of 50 psi. The maximum operating temperature is 210° F.

Connectors shall be flanged. Required sizes are shown on the Drawings. For each connector, provide thrust restraint system to limit elongation and compression of the flexible connection.

4. All fittings and connections for tubing shall be Swagelok or equal.

I. Pipe Hangers and Supports.

1. General

a. Piping shall be supported, in general, as described hereinafter and as shown by the pipe support details on the Drawings. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports and hangers to be employed. Special support and hanger details are shown to cover typical locations where standard catalog supports are inapplicable.
b. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing supports for the piping shown on the Drawings at the spacing specified below.
c. All submerged piping supports, guides, and fasteners shall be Type 316 stainless steel unless otherwise shown. Concrete anchors and anchor bolts shall also be Type 316 stainless steel.
d. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment.
e. Pipe support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of 5.

2. Building Piping:

a. Horizontal piping shall be supported with adjustable swivelring, split-ring, or Clevis type hangers as shown. Furnish galvanized protection shield and oversized hangers under all insulated piping. Pipe hangers for plastic piping shall be coated with a plastic or neoprene protective cover. No metal portion of a support or hanger shall contact pipe directly.
b. Stacked vertical and/or horizontal runs of piping along walls shall be supported by a fiberglass framing system attached with Type 316 stainless steel anchors or concrete inserts as

applicable, Unistrut, KinLine, or equal. No pipe shall be supported from the pipe above or below it.

c. Pedestal pipe supports shall be adjustable, with stanchion, saddle, and anchoring flange as shown. Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation. Pads shall be Mason Industries, Inc., Korfund Korpad, or equal.

d. Horizontal piping hanger support rods shall attach to steel beams with C -clamps or beam clamps; to concrete with inserts, brackets or flanges fastened with flush shells; to wood not less than 2-½" thick with lag screws and angle clips.

e. Piping supports for vertical piping passing through floor sleeves shall be galvanized steel riser clamps, Grinnell Figure 261; or equal.

f. All hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories shall be hot dip galvanized.

g. Horizontal pipe support or hanger spacing and hanger rod sizing shall be as shown on the Drawings.

h. The load rating for universal concrete inserts shall not be less than that of the hanger rods they support.

i. When supporting ductile iron pipe, locate hanger rods at all nonrigid joints and at each change of direction.

j. Vertical sway bracing shall be provided where shown, or on 10' maximum centers.

k. All piping shall be supported in a manner which will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown.

J. Slab, Floor, Wall, and Roof Penetrations and Closures

1. All piping penetrations of slabs, floors, walls, and roofs shall be ductile iron wall pipes with integrally cast seep rings, unless otherwise noted on the Drawings. It shall be the Contractor's responsibility to verify the size and location of all building and structure penetrations prior to pouring concrete.

a. Ductile Iron Wall Pipes:

1) Provide ductile iron wall pipes where ductile iron piping passes through concrete walls, floors, slabs and roofs which are to be watertight and where shown on the

Drawings. Wall pipe end connections shall be as shown on the Drawings and as specified herein. Wall pipes shall be of a thickness equal to or greater than the remainder of the piping in the line and shall comply with the requirements for fittings in the applicable Specifications. All wall pipes shall be provided with seep rings. Seep rings shall be of ductile iron and cast integral with the wall pipe where offered or catalogued by the manufacturer. All wall pipes that cannot be cast with integral seep rings shall be fabricated by welded attachment of the seep ring to the pipe. All welds shall be done in the manufacturer's shop by qualified welders and shall be electric arc welds of ductile iron to ductile iron with NI-55 or FC55, -nickel-ironcarbon- weld rod. The seep ring shall be ductile iron, welded continuously around the pipe on both sides; alternatively, the seep ring shall be steel, as shown in the Standard Details.

2) Flanges set flush with the face of concrete shall be tapped for stud bolts.

3) Coat outside wall of pipes as specified in Section 09900, Painting. Support wall pipes by formwork to prevent contact with reinforcing steel.

b. Pipe Sleeves

1) Piping passing through concrete or masonry shall be installed through galvanized steel pipe sleeves where shown on the Drawings. Holes drilled with a suitable rotary drill will be considered in lieu of sleeves in existing walls.

2) All sleeves in exterior or water bearing- walls shall have a center flange for water stoppage. The annular space between pipes and sleeves in exterior walls shall be watertight. The joint shall be caulked with rubber sealant or sealed by a modular mechanical unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. The interconnected rubber links shall be assembled with zinc phosphateplated steel bolts and nuts and steel pressure plates under each bolt-head and nut to prevent the nut from turning when the bolt is tightened. Tightening of the bolts shall cause the rubber sealing links to expand, resulting in a watertight

seal between the pipe and wall sleeve opening. Closures shall be sized according to manufacturer's instructions for the size of pipes shown on the Drawings.

3) Wall sleeves shall be coated with the appropriate system for the intended location as specified in Section 09900, Painting. When placing Non-nsulating- type wall sleeves in concrete forms, support them by formwork to prevent contact with the reinforcing steel.

K. Polyvinyl Chloride Pipe and Fittings (PVC Gravity Pipe):

1. Polyvinyl chloride pipe shall be of unplasticized compounds suitable for use with wastewater.

L. Flexibility:

1. Unless otherwise specified, piping 2" in diameter and larger passing from concrete to earth or from below a structure to outside of the structure shall be provided with two pipe couplings or flexible joints. The first joint shall be within 2' of the face of the structure. The second joint shall be located 2' or one pipe diameter (whichever is greater) after the first joint. Where required for resistance to pressure, mechanical couplings shall be restrained as specified elsewhere.

M. Expansion Joints:

1. Expansion joints shall be designed in accordance with Expansion Joint Manufacturer's Association (EJMA) standards for pressure, temperature and service as specified.

2. Expansion joints shall be multi-ply bellows type designed for temperatures up to 300^0 F and pressures up to 25 psig. Bellows shall be constructed of 300 series stainless steel. Unless otherwise specified, end connections shall be flanged. Flanges shall be of stainless steel construction.

3. The type of expansion joints and schedule is specified on the Drawings.

4. Expansion joints shall be as manufactured by Flexonics, Inc., Hyspan Precision Products, Inc., American BOA, Inc., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All exposed piping shall be firmly anchored and supported by pipe supports or anchors as shown or required. Pipe supports shall be furnished as shown on the Drawings or in accordance with the requirements of Paragraph 2.01 M of this section. All pipes shall be carefully placed to the proper lines and grades as shown on the Drawings.

2. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings will not be permitted. Pipe shall be cut to exact measurement and shall be installed without forcing or springing.

3. Lines which slope shall have the right-of-way over lines whose elevations can be changed. Offsets, transitions, and changes in direction in pipes shall be made as required to maintain- proper head room, slope, etc.

4. Piping shall be installed in such manner and at such times as will require a minimum of cutting and repairing of building structures. In case any such cutting or repairing is necessary, it shall be done only with the permission of the Engineer. Cutting and repairing shall be performed by craftsmen of the trade which originally executed the work, and repairs shall match the original condition.

5. All changes in direction in piping systems shall be made with suitable fittings.

6. When storing and installing pipe, care shall be taken to prevent damage to the pipe coatings. All damaged coatings shall be repaired to the satisfaction of the Engineer.

7. A liberal number of unions and/or flanged joints shall be used to permit the ready removal of any section. Unions shall be installed in all piping connections to equipment, to regulating valves, and wherever necessary to facilitate the dismantling of piping and removal of valves and other items requiring maintenance. Flanges on equipment may be considered as unions.

8. Installed piping shall not interfere with the operation of or accessibility to doors and/or windows, shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment.

9. The interior of all piping shall be free from obstructions and protrusions. All burrs shall be removed from the inside and outside edges of all cut pipe by reaming. Cutting shall be done in such a manner so as to leave a smooth end at right angles to pipe threads. Tool marks and unnecessary pipe threads shall be avoided. Cuttings and other foreign material shall be removed from the inside of the pipe prior to installation.

10. After installation, the interior of all piping shall be cleaned as necessary to remove flux, slag, scale, rust, dirt, oil, and other foreign material. As piping is installed, open ends shall be covered or plugged as necessary to prevent the entrance of foreign matter and to maintain the required cleanliness.

11. Changes in pipe size shall be made using reducing fittings, not bushings. If centerline elevation is not specified, use eccentric reducers in horizontal piping. On liquid lines, eccentricity shall be down with top of pipe level. On vapor and gas lines, eccentricity shall be up with bottom level.

12. Indicated locations and sizes of equipment connections are approximate; exact locations and sizes of piping, valves, etc., shall conform to approved shop drawings. Connection sizes shall not be smaller than scheduled size or equipment outlet size, whichever is larger.

13. One inch vent and drain valves shall be inserted in all high and low points of all pipes.

14. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.

15. Minimum pipe cover shall be 3', as measured from the pipe barrel, unless otherwise indicated on the Drawings.

C. Installation of Stainless Steel Pipe, tubing and fittings:

1. Welding electrodes for shielded metal arc process on Type 304L and 316L stainless steel pipe shall be AWS 5.4, E 308L; Gas Tungsten Arc or Gas Metal Arc process shall be AWS 5.9, ER 308L. The direct current, reverse polarity, shielded metal arc or gas metal arc processes or direct current, straight polarity, gas tungsten-arc process shall be used for all field welding.

2. All welding shall be conducted in accordance with latest editions of

Section IX, ASME Boiler and Pressure Vessel Code and the American National standard Code for Pressure Piping, ANSI B31.2 and B31.3, as applicable.

a. All welders and welding operators shall be qualified at the Contractor's sole expense by an ASMEapproved testing laboratory before performing any welding under this section. Qualification tests shall be in accordance with- Section IX, Article III of the ASME Boiler and Pressure Vessel Code. Welders and welding operators shall be qualified for making groove welds in Type 304, 304L, 316 and 316L stainless steel pipe in position 6G for each welding process to be used.
b. Pipe edges shall be prepared preferably by machine shaping or cutting with an aluminum oxide blade. Oxygen or arc cutting are acceptable only if the cut is reasonably smooth and true and all slag is removed either by chipping or grinding. Beveled ends for butt welding shall conform to ANSI B16.25. Surfaces to be welded shall be clean and free of paint, oil rust, scale, slag, or other material detrimental to welding. Prior to welding, wire brush joints to be welded with stainless steel wire brushes or stainless steel wool.
c. No welding shall be performed if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32° F. If the ambient is less than 32° F, local preheating to a temperature warm to the hand is required.
d. Each layer of deposited weld metal shall be thoroughly cleaned prior to the deposition of each additional layer of weld metal, including the final pass, with a power driven- stainless steel wire brush. Surface defects which will affect the soundness of weld shall be chipped out or ground out.
e. Welds shall be free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity, slag inclusions and other defects in excess of the limits prescribed in Chapter V of ANSI B31.2 and B31.3, as applicable.

D. Installation of PVC Pipe and Fittings:

1. All PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturers recommendations. Plastic pipe shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and final use.

2. Use Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting. All PVC to metal or PVC to FRP pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings, nor shall PVC piping be threaded into metal valves, fittings, or couplings.

3. Only strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to overtighten these fittings. Pipe shall not be laid when the temperature is below 40° F, nor above 90° F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.

E. Installation of Ductile Iron Pipe:

1. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.

2. Ends of pipe in accordance with the type of joint to be made. Dress cut ends of mechanical joint pipe to remove sharp edges or projections which may damage the rubber gasket. Dress cut ends of pipe for flexible couplings and flanged coupling adapters, as recommended by the coupling or adapter manufacturer. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.

3. Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened so that the pressure on the gasket is uniform. Torque limiting wrenches shall be used to ensure uniform bearing insofar as-possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.

4. Mechanical joint push-on, and restrained joint pipe shall be joined in accordance with the manufacturer's recommendations. Provide all special tools and devices such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes shall be permitted under any circumstances.

F. Installation of Sanitary and Waste Drain and Vent Piping.

1. Set sanitary and waste drain and vent piping installed above floor slab true and plumb.

2. Set exposed risers as close to walls as possible.

3. Make roof penetrations watertight.

4. Extend vents at least 1 foot above roof.

5. Properly slope sanitary and waste drainage piping encased in concrete.

6. Coordinate routing of drains through steel reinforcement with affected trades.

7. Make changes of direction in waste piping with combination Y and _ bend fittings.

8. Cleanout Fittings and Plugs:
    a. Install where shown and where required by plumbing code.
    b. T or Y branches or trap hubs shall be of the same material as the pipe in which they are installed.

G. Installation of Roof Drainage Piping.

1. Make changes of direction in horizontal roof drainage piping with 45 degree- fittings.

2. Make changes of direction in underground lines with combination Y and bend fittings.

3. Cleanout Fittings and Plugs:
    a. Install where shown and where required by plumbing code.
    b. Same material and size as pipe in which they are installed.

H. Buried Piping System Thrust Restraint

1. General: Thrust restraint for all buried ductile iron pressure piping systems shall be accomplished by the use of restrained joints as specified hereinbefore.

2. Buried Pressure Pipelines:
    a. Thrust restraint shall be capable of restraining the buried pressure pipelines for pressures up to 1-½ times the corresponding hydrostatic test pressures listed in the Piping Schedule.
    b. Restrained joint type fittings for ductile iron pipe shall be as specified hereinbefore.

I. Pipe Dope:

1. All threaded connections shall be made up using Teflon pipe dope applied to the male threads only.

2. Virgin Teflon thread tape shall be Hercules Packing Company "Herculon", 3-M Company "Scotch No.48", Crane Packing Company "Teflon Thread tape", or equal.

3. Teflon thread paste may be used in place of tape on very large or very small joints.

J. Wall Pipes and Pipe Sleeves

1. The Contractor shall provide restrained joints for all buried piping, except RCP, with test pressure higher than 20 psig.

2. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as specified in Section 03300, CONCRETE and as shown. Support all pipes embedded ill concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.

K. Flexible Couplings, Flanged Coupling Adapters, and Service Saddles

1. Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Workmen tightening bolts shall use torque limiting- wrenches.

2. (Not used)

L. Insulating Flanges, Couplings, and Unions

1. Install insulating flanges, couplings, or unions wherever copper and ferrous metal piping are connected, wherever submerged metallic piping is connected to unsubmerged piping, and where shown on the Drawings. Insulated joints connecting submerged piping to exposed piping shall be installed above maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive bonded- concrete anchors. All submerged metallic piping shall be isolated from the concrete reinforcement.

2. (Not used)

M. Insulation

1. All piping and equipment shall be insulated in accordance with manufacturer's instructions including types of insulating cements, lagging adhesives, and weatherproof mastics if different from those specified.

2. All insulation shall be applied over clean, dry surfaces with all joints butted firmly together, but not until piping system has been pressure tested and any leaks corrected. Insulation shall not extend beyond flanges nor cover nameplates or code inspection stamps. Insulation shall run continuous through wall openings, ceiling openings, and pipe sleeves, unless otherwise noted.

3. Where connection is shown to existing piping, the existing insulation shall be cut back to remove the portion damaged by the piping revisions, and new insulation installed. The joint between the old and new insulation shall be finished as hereinbefore specified.

4. The Contractor shall furnish precut, sized sections of closed cell rigid insulation with vapor barrier to be inserted under piping and centered at each hanger location. Provide continuous vapor barrier at all joints between rigid insulation and pipe insulation.

5. Insulate all valve bodies, flanges, and pipe couplings. Provide removable insulation sections on all devices that require access for maintenance of equipment or removal, such as unions, strainer end plates, etc. Do not insulate flexible pipe couplings.

6. Finished appearance of all insulation shall be smooth and continuous. Provide coating of insulating cement where needed to obtain this result. Joints shall be lapped and the integrity of vapor seals maintained in strict accordance with manufacturer's instructions. Staples and screws shall not be used to secure components of systems that are vapor sealed.

7. Care shall be taken to apply the insulation and vapor barrier coating on exterior piping so that it will not be damaged when the prefabricated aluminum fitting covers are applied. The prefabricated aluminum covers shall serve as weatherproof enclosures over fittings. No screws or rivets shall be used in fastening the fitting covers, as they may puncture the vapor seal.

8. Exterior flanges and unions shall have removable prefabricated aluminum covers.

9. Heat Tracing: Install heat tracing tape in strict accordance with the manufacturers' recommendations and make electrical connections.

3.02 SURFACE PREPARATION AND SHOP PAINTING

A. All ferrous piping not specified to be galvanized or otherwise coated shall be cleaned and shop primed or coated in accordance with the requirements of Section 09900, Painting.

3.03 FIELD PAINTING

A. Following installation and testing, all exposed piping, including insulated piping, shall be field primed and painted in accordance with the requirements of Section 09900, Painting. Stainless steel pipe and fittings shall not be painted.

3.04 PIPING IDENTIFICATION

A. Piping Systems. Identification of piping systems shall conform to ANSI A13.1, Scheme for the Identification of Piping Systems, unless otherwise specified herein.

B. Process Piping Code. All exposed pipe shall be identified by color and labeling to show its function. Stencil-painted labels and arrows showing the direction of flow shall be installed every 20' or each change of direction at each valve, and on each side of wall penetrations. Piping which is not painted shall be provided with 6" wide color bands as specified. Color bands of an approved tape may be used on PVC, FRP and stainless steel pipe and other pipe which does not readily accept painted finish. The color, banding and labeling shall conform to the schedule in Section 09900, Painting.

C. Process Valve Identification. After the painting of process piping is complete, the Contractor shall stencil the tag numbers of all valves numbered on the Process and Instrumentation Drawings, on the pipe adjacent to the valve for pipe 2" and over. Characters shall be 2" high minimum and shall be oriented to be visible from the valve operating position. When the valve has extended operator shaft or chain operator, the number shall be placed at both the operating position and at the valve, if practicable; this requirement does not apply if the valve is buried or in a pit. Valves in pipes under 2" shall have characters as large as the pipe will permit or at the Engineer's option on an adjacent surface. Characters shall be preferably white; however, if this would

not provide sufficient contrast to the pipe, the Engineer may select another color. Paint used shall be of the same type and quality as that used for painting the pipe.

3.05 TESTING

A. General: Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. The Engineer will monitor the tests. Test pressures shall be as specified in the Piping Schedule.

B. Testing New Pipe Which Connects to Existing Pipe: New pipelines which are to be connected to existing pipelines shall be tested by isolating the new Pipe.

C. Preparation and Execution:

1. Buried Pressure Piping:
    a. Conduct final acceptance tests on buried pressure piping that is to be hydrostatically tested after the trench has been completely backfilled. The Contractor may, if field conditions permit, as determined by the Engineer, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The acceptance test shall not, however, be conducted until all backfilling has been completed.
    b. Buried pressure piping that is to be pneumatically tested or subjected only to an initial service leak test shall have all joints exposed for the acceptance test.

2. Exposed Pressure Piping: Conduct the tests on exposed piping after the piping has been completely installed, including all supports, hangers, and anchors, but prior to insulation.

3. Hydrostatic Leak Tests:
    a. Equipment: Furnish the following equipment for the hydrostatic tests:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

b. Procedure: Water shall be used as the hydrostatic test fluid unless otherwise specified. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The hydrostatic test pressure shall be continuously maintained for time duration specified in pipe schedule and for such additional time as may be necessary to conduct examinations for leakage. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.

C. Buried Water and Wastewater Pressure Lines:

1. Some leakage is permissible from buried water and wastewater pressure lines. Consequently, the hydrostatic testing of these pipelines must be conducted in a different manner, as follows:

2. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 5 days have elapsed after the thrust blocking is installed. If high early cement is used for thrust blocking, the time may be reduced to 2 days. When testing -cement mortar- lined piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the cement mortar- lining to absorb water.

3. Expel all air from the piping system prior to testing and apply and maintain the specified test pressure by means of the hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for 2 hours, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. This measurement represents the leakage, which is defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{ND(P)^{1/2}}{7400}$$

In the above formula:

L = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipe tested
D = Nominal diameter of pipe, in inches
P = Test pressure during the leakage test, in pounds per square inch

The Contractor shall correct any leakage greater than the allowance determined under this formula at the Contractor's sole expense.

4. Pneumatic Leak Tests:
   a. Equipment: Furnish the following equipment for the pneumatic tests:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105% of the required primary test pressure
1	Calibrated test gauge

   b. Procedure:
      1) Pneumatic testing shall be performed using accurately calibrated instruments and oil-free, dry air. Tests shall be performed only on exposed piping, but only after the piping has been completely installed, including all supports, hangers and anchors, and inspected for proper installation. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The Contractor shall recognize the hazards associated with air testing and shall take all necessary precautions to protect test personnel and City's operating personnel. All piping to be tested shall be secured to prevent damage to adjacent piping and equipment in the event of a joint failure. Any appurtenant instruments or devices that could be damaged by the test shall be removed from the piping or suitably isolated prior to

applying the test. Prior to starting the test, the Contractor shall notify the Engineer.

2) A preliminary pneumatic test not to exceed 25 psig shall be applied to the piping system prior to final leak testing, as a means of locating major leaks. Examination for leakage, detected by soap bubbles, shall be made at all joints and connections. After all visible leaks have been corrected, the pressure in the system shall gradually be increased to not more than ½ of the test pressure, after which the pressure shall be increased in steps of approximately 1/10 of the test pressure until the required test pressure has been reached. The pneumatic test pressure shall be continuously maintained for a minimum time of 10 minutes and for such additional time as may be necessary to conduct a soap bubble examination for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage. Any visible leakage shall be corrected at the Contractor's sole expense.

3) Following pneumatic testing, lines which are to carry flammable gases shall be thoroughly purged with nitrogen to assure that no explosive mixtures will be present in the system during the filling process.

5. Initial Service Leak Tests:
   a. Equipment: Equipment used for initial service leak testing may be the same as that specified under Paragraphs Hydrostatic Leak Tests and Pneumatic Leak Tests hereinbefore.
   b. Procedure: The initial service leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. Soap bubbles shall be used to detect leaks in pneumatically tested- systems. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.

7. Test Records: Records shall be made of each piping system installation during the test. These records shall include:

a. Date of test
b. Description and identification of piping tested
c. Test fluid
d. Test pressure

7. Remarks, to include such items as:
    a. Leaks (type, location)
    b. Repairs made on leaks

3.06 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of debris within piping sections. All piping shall be examined to assure removal of foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.07 FINAL CLEANING

A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except plant process air lines and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 fps. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Engineer. Accumulated debris shall be removed through drains 2" and larger or by dropping spools and valves. Immediately following drainage of flushed lines, the piping shall be air dried with compressed air.

B. Plant process air and instrument air piping shall be blown clean of loose debris with compressed air.

3.08 CORROSION PROTECTION OF PIPING SYSTEMS

A. All atmospheric exposed piping and piping components including, but not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves and fasteners shall be painted in accordance with Section 09900, Painting, as applicable to the base metal material.

B. Pipe support systems shall be painted No. 70, light gray, as specified in ANSI Z55.1; Tnemec Co., Inc. No. 2050; or equal.

C. Corrosion protection for buried piping systems, other than copper piping, is not required.

3.09 CORROSION PROTECTION FOR COPPER PIPING

A. For Atmospheric Exposed Copper Pipe: Copper piping shall be painted in accordance with Section 09900, Painting System No. 5.

B. Exterior Coating for Buried Copper Pipe: All buried copper pipe shall be coated by hand taping with pipe tape. The pipe surface shall be solvent cleaned, SSPC-SP 1, and wire brushed, SSPC-SP 3, to remove all dirt and loose rust and mill scale, and immediately primed with the tape manufacturer's recommended primed in accordance with the manufacturer's recommendations. The tape shall be spirally applied to the pipe with a 50 percent overlap minimum after the primer has thoroughly dried. Joints shall be tape wrapped or heat shrink wrapped above grade to permit joint wrapping without contamination. Tape wrapping and heat shrink wrapped are specified under Paragraph MATERIALS.

3.10 DISINFECTION

A. Pipelines intended to carry potable water shall be disinfected before placing in service. Disinfecting procedures shall conform to AWWA C651-86, as hereinafter modified or expanded.

B. Flushing: Before disinfecting, flush all foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc. as required to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipeline in place from the inside by brushing and sweeping, then flush the line at the higher velocity.

C. Disinfecting Mixture:

1. Disinfecting mixture shall be a chlorine water solution having a free chlorine residual of 50 ppm, minimum. The disinfecting mixture shall be prepared by injecting: (1) A liquid chlorine -gas water- mixture; (2) dry chlorine gas; or (3) a calcium or sodium hypochlorite and water mixture into the pipeline at a measured rate while fresh water is allowed to flow through the pipeline at a measured rate so that the combined mixture of fresh water and chlorine solution or gas is of the specified strength.

2. The liquid chlorine gas-water mixture shall be applied by means of a standard commercial solution feed chlorinating device. Dry chlorine gas shall be fed through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe

being treated. Chlorinating devices for feeding solutions of the chlorine gas or the gas itself must provide means for preventing the backflow of water into the chlorine cylinder.

3. If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a 1% solution (10,000 ppm chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1% solution. The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite[1] (65-70% Cl)	1 lb	7.5 gal.
Sodium Hypochlorite[2] (5.25% Cl)	1 gal.	4.25 gal.
[1] Comparable to commercial products known as HTH, Perchloron, and Pittchlor. [2] Known as liquid laundry bleach Clorox and Purex etc.		

4. Point of Application: Inject the chlorine mixture into the pipeline to be treated at the beginning of the line through a corporation stop or suitable tap in the top of the pipeline. Clean water from the existing system or another source shall be controlled so as to flow slowly into the newly installed piping during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 50 ppm of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.

5. Retention Period:
    a. Treated water shall be retained in the pipeline long enough to destroy all non-spore forming- bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the retention period, the disinfecting mixture shall have a strength of at least 10 ppm of chlorine.
    b. Operate all valves, hydrants, and other appurtenances during disinfection to assure that the disinfecting mixture is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.
    c. Do not place concentrated quantities of commercial disinfectants in the line before it is filled with water.
    d. After chlorination, flush the water from the permanent source of supply until the water through the line is equal chemically and bacteriologically to the permanent source of supply.

e. Disposal of Disinfecting Water: Dispose of disinfecting water in an acceptable manner that will protect the public and publicly used. Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.

6. Collect two samples or sets of samples from each pipe or facility at least 24 hours apart. Submit samples to a state-approved laboratory for bacteriological (coliform and non-coliform) analysis. Continue disinfecting and testing until bacteriological clearance is achieved.

END OF SECTION 15060

SECTION 15100
VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.

B. Items included under this Section are:

1. Ball Valves (V1)
2. Gate Valves (V2)
3. Plug Valves (V5)
4. Butterfly Valves (V6)
5. Check Valves Swing Check (V7)
6. Valve Boxes
7. Tapping Sleeves and Gate Valves
8. Air Release Valves (V9)
9. Flange Insulating Gasket Kits
10. Electronic Locating and Marking Systems

1.02 DESCRIPTION OF SYSTEMS

A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of water.

1.03 QUALITY ASSURANCE

A. 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.

1. ANSI/AWWA C504 – Rubber-Seated Butterfly Valves

2. ANSI/AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service

3. ANSI/AWWA C515 – Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.

4. ANSI/AWWA C550 – Protective Epoxy Interior Coatings for Valves and Hydrants.

5. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

6. ANSI/NSF Standard 61 – Drinking Water System Components – Health Effects

1.04 SUBMITTALS

A. Submittals shall be in compliance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Complete shop drawings of all valves and appurtenances

2. Manufacturer's certificate certifying that the products meet or exceed the specified requirements.

1.05 TOOLS

A. Special tools, if required for normal operation and maintenance, shall be supplied with the equipment.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. All valves and appurtenances shall be of the size shown on the Drawings and all equipment of the same type shall be from one manufacturer.

B. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

2.02 BALL VALVES

A. Rubber Seated ball valves (4-inch and smaller):

1. Ball valves up to 1-1/2-inch (incl.) in size shall have PVC, stainless steel or brass with screwed ends for a pressure rating of not less than 600 psi WOG.

2. Valves 2-inch to 4-inch in size shall have PVC or stainless steel bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated. The balls shall be rubber with full port openings.

3. The valve stems shall be of the blow-out proof design, stainless steel, with reinforced Teflon seal. The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.

4. Ball valves shall be as manufactured by Conbraco Industries, Inc. (Apollo); ITT Engineered Valves; Neles-Jamesbury, Inc; NIBCO, Inc.

2.03 GATE VALVES

A. 20 Inches in Diameter and Smaller:

1. Gate valves shall be resilient seated type conforming to the requirements of AWWA C509 or AWWA C515.

2. Valves shall have a minimum working pressure of 250 psi.

3. Valve manufacturer shall submit an affidavit to the Engineer indicating valve compliance with all applicable AWWA standards.

4. Valves less than 4" in diameter shall have threaded ends. Larger valves shall be mechanical joints unless shown otherwise on the Drawings.

5. Valve shall be non-rising stem type with a 2" square operating nut and shall open right (clockwise).

6. All internal and external ferrous surfaces shall be coated with epoxy to a minimum thickness of 4 mils. The epoxy shall conform to ANSI/AWWA C550 and shall be applied electrostatically prior to assembly. Epoxy shall be NSF61 approved.

7. Valve shall have a ductile iron body, bonnet, and stuffing box. All joints between valve parts, such as body and bonnet, bonnet and bonnet cover, shall be supplied with O-ring seals.

8. Valve wedges shall be symmetrical, made of ductile iron and totally encapsulated in rubber. Rubber shall be permanently bonded to the wedge per ASTM D429.

9. Valves shall be manufactured by American Flow Control, Mueller, or M & H Valve.

B. 24 Inches in Diameter and Larger:

1. Gate valves shall be resilient seated type conforming to the requirements of AWWA C509 or AWWA C515.

2. Valves shall have a minimum working pressure of 250 psi.

3. Valve manufacturer shall submit an affidavit to the Engineer indicating valve compliance with all applicable AWWA standards.

4. Valves shall be designed for horizontal installation with tracks and rollers, bypass valves, and bevel gear type operator.

5. Valve ends shall be mechanical joint type except where restrained joint ends are shown. Flanged joints shall meet the requirements of ANSI B16.1, Class 125.

6. Valve shall be non-rising stem type with a 2" square operating nut and shall open right (clockwise).

7. All internal and external ferrous surfaces shall be coated with epoxy to a minimum thickness of 4 mils. The epoxy shall conform to ANSI/AWWA C550 and shall be applied electrostatically prior to assembly. Epoxy shall be NSF61 approved.

8. Valve shall have a ductile iron body, bonnet, and stuffing box. All joints between valve parts, such as body and bonnet, bonnet and bonnet cover, shall be supplied with O-ring seals.

9. Valve wedges shall be symmetrical, made of ductile iron, and totally encapsulated in rubber. Rubber shall be permanently bonded to the wedge per ASTM D429.

10. Valves shall be non-rising stem type with a 2" square operating nut and shall open right (clockwise).

11. Valves shall be manufactured by American Flow Control, Mueller, or M & H Valve.

2.04 PLUG VALVES

A. Valves shall be 90-degree turn, nonlubricated, eccentric type with resilient faced plugs. Design of the valve shall provide that contact between the seat and the plug shall only occur in the final degrees of plug movement. -Valves shall be suitable for throttling service and service where valve operation is infrequent.

B. Valves shall provide drip tight- shutoff up to the full pressure rating with pressure in either direction. Pressure ratings shall be established by

hydrostatic tests conducted in accordance with- ANSI B16.1. Valves shall be rated at a minimum of 150 psi.

C. Valves shall have a port area equal to at least 80% of the full pipe area.

D. Bodies shall be cast iron-, conforming to ASTM A 126, Class B (carbon steel for 2-inch valves).

E. Valve ends shall be a mechanical joint type, except where flanged or restrained joint ends are shown on the Drawings. Mechanical joint valves shall have bell ends conforming to applicable requirements of AWWA C111/ANSI A21.11. Flanged joints shall meet the requirements of ANSI B16.1, Class 125. Flanged valves with flange to- -MJ adapters shall not be acceptable in lieu of MJ valves.

F. Valve seats shall be raised, welded in overlay of not less than 90% pure nickel, machined to mate with the resilient faced plug. Overlay shall be minimum- of 1/8" thick.

G. The plug shall be semi steel, conforming to ASTM A 126, Class B. The- plug facing shall be a synthetic rubber compound of approximately 70 durometer hardness bonded to the plug. Facing material shall be abrasion resistant and suitable for service in sewage and sludge applications.

H. Valves shall be furnished with replaceable, sleeve-type bearings in the upper and lower journals. Bearings shall comply with applicable requirements of AWWA C507. Bearing materials shall have a proven record of service of not less than five years.

I. The valve body shall be fitted with a bolted bonnet incorporating a stuffing box and pull-down packing gland. Packing shall be the split chevron type. Design of exposed valves shall allow visible inspection of the shaft seal, adjustment of the packing, and replacement of the packing, all without disturbing the bonnet or valve operator. The shaft seal shall comply with the requirements of AWWA C517.

J. Actuators

1. Valves for exposed service, 3" through 8" in diameter, shall be lever operated. Hand levers shall be steel with a non-metallic grip.

2. Actuators for buried service and valves 10" and larger, shall be equipped with manual operated geared actuators. Geared actuators shall be totally enclosed, oil lubricated, worm and gear type. Shaft seals shall be provided to prevent entry of dirt and water into the actuator. All shaft bearings shall be permanently lubricated bronze bushings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque.

Construction of actuator housing shall be semi steel. Gear actuators shall comply with the requirements- of AWWA C517.

3. Gear actuators for buried valves 10" and larger shall be mounted above ground on an extended bonnet except when the valve is located in paving or has 8' or less cover.

4. Motorized actuators for open/close control shall be provided where shown on the Drawings and as specified in this Section. Each Actuator shall be equipped with “Open” and “Close” limit switches, and “Fault” contact rated for 5 Amp, 120VAC. See Electrical Drawings for additional information.

5. Valves and operators for submerged or buried service shall have seals on all shafts and gaskets on valve operator covers to prevent the entry of water. Operator mounting brackets for submerged service shall be totally enclosed and shall have gasket seals.

6. Actuators shall be manufactured by Limitorque; Rotork; Auma; EIM or any other City approved equal.

K. Operators

1. Valves for Non buried service, 6' or more above the operating floor shall be furnished with a chainwheel operator and chain for operation from floor level. -All other valves shall be equipped with a handwheel operator.

2. Valves, 3" through 8", for buried service shall have a nut type operator and shall be equipped with a valve box and stem extension required to bring the operation nut within 6" of finished grade. Valve boxes and extension stems shall be as specified in this Section.

L. Plug valves shall be manufactured by DeZurik, Pratt, or Valmatic.

2.05 BUTTERFLY VALVES

A. Class 150 Valves:

1. Class 150 butterfly valves shall be short body design and shall be designed, manufactured and tested in accordance with the requirements of ANSI/AWWA C504 for Class 150B butterfly valves.

2. Valve bodies shall be ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A126, Grade B cast iron. Shafts shall be ASTM A276, Type 304 stainless steel, machined and polished. Valve discs shall be ductile iron, ASTM A536, Grade 65-45-12 or ASTM A126, Grade B cast iron.

3. The valve shall have a resilient seat.

B. Actuators

1. Valves shall be equipped with traveling nut, self-locking type electric actuators designed, manufactured and tested in accordance with ANSI/AWWA C504. Actuators shall be capable of holding the valve disc in any position between fully open and fully closed without any movement or fluttering of the disc.

2. Actuators shall be furnished with fully adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. Actuators that utilize the sides of the actuator housing to limit disc travel are unacceptable.

3. Valve actuators shall be capable of withstanding a minimum of 450 foot pounds of input torque in either the open or closed position without damage.

C. The valve actuator shall be factory mounted on the valve by the valve manufacturer and shipped to the project site as a complete operating unit. Valve shall be designed to open right (counterclockwise).

D. Valve ends shall be mechanical joint type, except where flanged or restrained joint ends are shown on the Drawings. Flange joints shall meet the requirements of ANSI B16.1, Class 150.

E. Butterfly valves shall be manufactured by GA, Mueller, Pratt or DeZurik.

2.06 BYPASS VALVES AND PIPING

A. Where shown on the Drawings, valves 24 inches in diameter and larger shall be installed with bypass piping and valve as specified in the following table:

Valve Diameter (Inches)	Bypass Valve and Pipe Diameter (Inches)
24	4
30	4
36	6
42	6
48	8
54	8
60	10

2.07 CHECK VALVES

A. Swing Disc Type, Cushioned

1. Check valves shall be hinged disc type with cast iron body and bronze or bronze fitted disc. Valves shall be designed for the operating head indicated- and shall not slam shut on pump shutdown. Valves shall be equipped with a 1/2" stop cock at the high point of the valve for bleeding air from the line.

2. Valves shall be outside weight and lever cushioned type. The cushion chamber shall be attached to the side of the valve body externally and constructed with a piston operating in a chamber that will effectively prevent water hammer at the pump discharge heads specified. The cushioning shall be by air, and the cushion chamber shall be so arranged that the closing speed will be adjustable to meet the service requirements.

3. Valve ends shall be flanged, meeting the requirements of ANSI B16.1, Class 125.

4. Valves shall be manufactured by APCO.

B. Swing Disk Type, Spring and Lever Type

1. Check valves shall be hinged disc type with cast iron body and bronze or bronze fitted disc. Valves shall be designed for the operating head indicated- and shall not slam shut on pump shutdown. Valves shall be equipped with a 1/2" stop cock at the high point of the valve for bleeding air from the line.

2. Valves shall be spring and lever type.

3. Valves shall be manufactured by APCO.

2.08 BLACKFLOW PREVENTER

A. Reduced pressure backflow preventers shall include two check valves with an independent relief between the valves, NRS isolation gate valves, three leak proof testing cocks, externally mounted strainer, and manufacturer's air gap assembly where shown on the Drawings. They shall be in accordance with AWWA C506, shall be rated 175 pounds cold water working pressure, and shall meet the requirements of USC Cross Connection Control Laboratory and ASSEE 1013. Assembly shall be Watts Regulator Co., Inc., Model 909 NRS.

1. Backflow preventers shall be the reduced pressure type, providing protection during the emergency conditions of either back-siphonage or backpressure or a combination of both. Backflow preventers shall be certified by a nationally recognized testing laboratory as conforming to current requirements of ASSE 1013, AWWA C 506, or USC-FCCC. The installation shall meet all applicable state and local codes.

2. Sizes ¾-inch through 2-inches shall have bronze bodies with threaded connections, a bronze union on either side and a stainer installed upstream of the device. Gate valves shall be installed upstream and downstream of the device.

3. Sizes 2½ inches and larger shall be bronze with corrosion resisting moving parts and trim and flange connections. Gate valves shall be installed upstream and downstream of the device.

4. The device shall be equipped with three (3) leak-proof test cocks. A fixed air gap, or funnel, shall be installed at the relief port. A drain line shall be piped from the discharge side of the air gap as shown on the Drawings shall be supported independently from the device.

5. Backflow preventers shall be manufactured by Watts, Wilkins, Hersey or equal

2.09 VALVE BOXES AND EXTENSION STEMS

A. All buried valves shall be equipped with valve boxes and lids unless access to the valve operator is provided by a manhole or vault.

B. Valve boxes shall be gray cast iron two-piece screw type with drop lids. Valve boxes shall be adjustable to 6" up or down from the nominal required cover over the pipe. Valve boxes shall have a 5-1/4" inside diameter. Valve boxes shall be of sufficient length that the bottom flange of the lower belled portion of the box is below the valve operating nut. Cast iron risers shall be provided as necessary. Valve boxes shall be model 8550 as manufactured by East Jordan Iron Works or equal.

C. Valve box lids shall be gray cast iron and shall have "WATER" cast into the top of the lid in ¾" (minimum) raised letters. Valve box lids shall weigh a minimum of 13 lbs. Valve box lids shall be model 6800 as manufactured by East Jordan Iron Works or equal.

D. Valve boxes, risers, and lids shall be coated with black asphalt.

E. All valves shall be furnished with extension stems if operating nut is greater than 4' deep, to bring the operating nut to within 24" of the top of the valve box. Connection to the valve shall be with a wrench nut coupling and a set screw to secure the coupling to the valve's operating nut. The coupling and square wrench nut shall be welded to the extension stem. Extension stems shall be stainless steel and shall be furnished by the valve manufacturer. Extension stems shall be sized by the valve manufacturer to withstand the maximum valve operator output.

F. Where pavement exists, the box shall be adjusted to finished grade. When valves are located out of pavement, the box shall be adjusted to finished grade and a concrete pad shall be poured around the box as detailed on the Drawings.

G. Stem guides shall be fully adjustable stem guides with bronze bushings, and shall be furnished by the valve manufacturer. Stem guides shall be installed as shown on the Drawings and shall conform to the extension guide spacing requirements as specified in AWWA/ANSI C501.

2.10 WRENCHES

A. Four tee handled wrenches of suitable length shall be furnished to operate all valves.

2.11 VALVE MARKERS (VM)

A. For installed valves, the Contractor shall furnish and install a concrete valve marker as detailed on the Drawings when directed by the Engineer, except on hydrant isolation valves. Valve markers shall be stamped “WATER”.

B. (Not Used)

2.12 TAPPING SLEEVES AND GATE VALVES

A. Tapping sleeves for mains 12" in diameter and smaller shall be ductile iron of the split sleeve-, mechanical joint type. Tapping sleeves shall be equal to Mueller H-615.

B. Tapping sleeves for mains larger than 12" shall be of all stainless steel construction.

C. The Contractor shall be responsible for determining the outside diameter of the pipe to be connected prior to ordering the sleeve. The tapping sleeve shall be rated 250 psi. working pressure.

D. Valves shall be gate valves as specified in Paragraph 2.02 of this Section, with a flanged connection to the tapping sleeve and a mechanical joint connection to the branch pipe. The tapping sleeve shall be supplied by the valve manufacturer.

2.13 AIR RELIEF VALVE

A. Air release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.

B. Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

C. Air and vacuum valves shall be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The set shall be fastened into the valve cover and shall be easily removed if necessary. The float shall be center or peripheral guided for positive shut off into the seat.

D. Valves shall be suitable for pressures up to 150 psi.

E. Isolation valves and small-diameter piping to local drain or sump shall be provided below each air valve.

F. Manufacturers shall be Vent-o-Mat, GA Industries, Valmatic, Apco, or Approved Equal.

2.14 FLANGE INSULATION GASKET KITS

A. Flange insulating gasket kits shall be installed as required to isolate dissimilar metals when connecting to pipelines of different metal composition.

B. Flange kits shall consist of insulation gaskets, insulating sleeves and washers, nuts and bolts.

2.15 ELECTRONIC LOCATING AND MARKING SYSTEMS

C. The Contractor shall furnish and install an electronic locating and marking system for all buried water main piping. System shall consist of electronic markers buried above the water main and stand-alone locators.

D. The marker shall contain an antenna or three orthogonal tuned circuits. Electronic ball markers shall be made of high strength 4 1/2" (maximum) diameter plastic. Electronic ball markers shall be 3M EMS model 1403-XR as manufactured by 3M, Omni Markers as manufactured by Tempo or approved equal.

E. Full range markers shall be equal to EMS model 1252 as manufactured by 3M or approved equal.

F. The Contractor shall also furnish two (2) 3M Dynatel locators. Locators shall be 3M model 2250M-ID/UU3W-RT or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.

B. Buried flanged or mechanical joints shall be made with cadmium plated bolts.

C. Prior to installation, valves shall be inspected for direction of opening clockwise, number of turns to open, freedom of operation, tightness of pressure containing bolting and test plugs, cleanliness of valve ports and especially seating surfaces, handling damage and cracks. Defective valves shall be corrected or held for inspection by the Engineer. Valves shall be closed before being installed.

3.02 LAYING AND JOINTING VALVES AND APPURTENANCES

A. Valves, fittings, plugs, and caps shall be set and joined to the pipe in accordance with the manufacturer's recommendations for cleaning, laying and joining pipe. Twelve (12) inch and larger valves shall be provided with special support, such as crushed stone, concrete pads or a tamped trench bottom so that the pipe will not be required to support the weight of the valve.

B. In no case shall valves be used to bring misaligned pipe into alignment during installation. Pipe shall be supported in such a manner as to prevent stress on the valve.

C. A valve box shall be provided on each buried valve. The valve box shall be set over the center of the valve operating nut and plumbed. The box shall not transmit shock or stress to the valve. The bottom portion of the lower belled portion of the box shall be placed below the valve operating nut. The flange shall be set on brick, so arranged that the weight of the valve box and superimposed loads will bear on the base and not on the valve or pipe. The valve box cover shall be flush with the surrounding surface or such other level as directed by the Engineer.

D. Underground valves shall be installed in vaults where indicated on the Drawings. The vault shall be precast, or cast-in-place concrete as indicated on the Drawings. The valve box shall not transmit shock or stress to the valve and shall be as detailed on the Drawings. The valve vault cover shall be flush with the surface of the finished area or such other level as directed by the Engineer.

E. Settlement Joints: The first joint on all pipes connected to and outside of a valve vault shall be designed to allow differential settlement. The following joints will be allowed for settlement:

1. Steel Pipe shall use a bolted, sleeve style coupling with joint harness as specified in AWWA M11.

2. Ductile iron pipe shall use standard gasketed joints if unrestrained or mechanically restrained gasketed joints if required by thrust restraint design.

F. Pipe within 20' of each side of a direct-buried butterfly valve shall be protected from vertical deflection to protect proper function of butterfly valve. Vertical deflection of pipe shall be limited to butterfly valve manufacturer recommendations.

3.03 BLOW-OFFS

A. Blow-offs shall be installed in locations as directed by the Engineer and as shown on the Drawings. Blow-offs shall not be connected to any sewer, submerged in any stream or creek, or be installed in any manner that will permit back siphonage into the water distribution system.

3.04 ELECTRONIC LOCATING AND MARKING SYSTEM

A. The Contractor shall install a ball marker at each bend, tee, valve and 500' of pipe length installed.

B. Ball markers shall be installed at a maximum depth of 5'.

C. Ball markers shall be secured to the pipe with cable ties as shown on the Drawings and shall be installed in accordance with the manufacturer's instructions.

D. Full range markers shall be installed on bends, tees, valves and pipes with 5' of cover or greater.

3.05 TESTING

E. After installation, all valves and appurtenances shall be tested at least 1 hour at 250 psi, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

END OF SECTION 15100

SECTION 15140
DUCTWORK SUPPORTS AND ANCHORS

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 installation of all supports and anchors. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer'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 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.

C. Work Included:

1. Duct, equipment hangers and supports.
2. Equipment bases and supports.
3. Sleeves and seals.
4. Flashing and sealing equipment.

D. Related Work Specified Elsewhere:

1. Section 15050, Basic Mechanical Materials And Methods.
2. Section 15891, Ductwork.
3. Section 15910, Ductwork Accessories.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions. In addition, the following specific information shall be provided:

1. Manufacturer's certification.
2. Manufacturer's data.
3. Shop drawings.
4. Relevant Experience: Provide a list of such installations complete with installation description contact names, addresses, telephone numbers.
5. Operation and maintenance manuals.

1.03 QUALITY ASSURANCE

A. 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. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ASTM, American Society for Testing Materials.
6. AISI, American Iron and Steel Institute.
7. NFPA, National Fire Protection Association.

B. 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.

1.04 QUALITY STANDARDS

A. The supports and anchors 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 amply designed and is a suitable application for these service conditions.

1.05 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 HANGER RODS

A. Steel Hanger Rods: Threaded both ends, threaded one end or continuous threaded.

2.02 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger.

2.03 FLASHING

A. For Flashing see Section 07620, Sheet Metal Flashing and Trim.

2.04 EQUIPMENT CURBS

A. Fabricated curbs shall be provided by equipment manufacturer supplying the associated equipment.

2.05 SLEEVES

A. Sleeves for round ductwork: Form with galvanized steel.

B. Sleeves for rectangular ductwork: Form with galvanized steel or wood.

C. Fire Stopping Insulation: Glass fiber type, noncombustible.

D. Caulk: Sealant of type and quality specified in Section 07900, Caulking and Sealants.

2.06 FABRICATION

A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

2.07 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.01 INSERTS

A. Provide inserts for suspended hangers from reinforced concrete slabs and sides of reinforced concrete beams.

B. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

C. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut flush with top of slab.

3.02 EQUIPMENT BASES AND SUPPORTS

A. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

B. Construct support of steel members. Brace and fasten with flanges bolted to structure.

3.03 FLASHING

A. Provide flexible flashing and metal counter-flashing where ductwork penetrates weather or waterproofed walls, floors and roofs.

B. Provide curbs for mechanical roof installations 12 inches minimum high above roofing surface. Flash seal watertight.

3.04 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Extend sleeves through floors one inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where ductwork penetrates floor, ceiling, or wall, close off space between duct and adjacent work with stuffing fire stopping insulation and caulk seal. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

D. Install chrome-plated steel escutcheons at finished surfaces.

END OF SECTION 15140

SECTION 15150
WATER SUPPLY BACKFLOW PREVENTION ASSEMBLIES

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidental required and install complete and ready for operation all backflow prevention assemblies as shown on the Drawings and as specified herein.

B. Items included under this Section include, but not be limited to the following:

1. Double Detector Check Backflow Preventer Assembly
2. Reduced Pressure Zone Backflow Preventer Assembly.

1.02 DESCRIPTION OF SYSTEMS

A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of water.

1.03 QUALITY ASSURANCE

A. 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.

1. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances
2. ANSI/AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service
3. ANSI/AWWA C510 – Double Check Valve Backflow Prevention Assembly
4. ANSI/AWWA C511 – Reduced- Pressure Principle Backflow Prevention Assembly
5. ANSI/AWWA C515 – Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service

1.04 SUBMITTALS

A. Submittals shall be in compliance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Complete shop drawings of all assembly components
2. Test Reports
3. Manufacturer's certificate certifying that the products meet or exceed the specified requirements

1.05 TOOLS

A. Special tools, if required for normal operation and maintenance, shall be supplied with the equipment.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. All assembly components shall be of the size shown on the Drawings and all equipment of the same type shall be from one manufacturer.

B. All assembly components shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon an appropriate part of the body.

2.02 DOUBLE DETECTOR CHECK BACKFLOW PREVENTER ASSEMBLY

A. Double detector check (DDC) backflow preventer (BFP) assembly shall be provided in sizes to match that of the required fire line service piping.

B. The DDC-BFP assembly shall be provided with OS&Y gate valves on the inlet and outlet sides of the assembly.

C. The DDC-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 DDC-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 DDC-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 DDC-BFP assembly shall be ¾-inch copper and have a bronze detector meter and a ¾-inch DCV-BFP complete with unions and shut off valves.

F. The DDC-BFP assembly shall be classified or listed by the Underwriters Laboratories, Factory Mutual Insurance and bear the ASSE seal (ASSE Standard 1049). The DDC-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 DDC-BFP assembly shall be individually factory tested, shipped and installed as a unit.

G. The DDC-BFP assembly shall be tested at the time of installation. A copy of all test reports shall be submitted to the Engineer.

2.03 REDUCED PRESSURE ZONE BACKFLOW PREVENTER ASSEMBLY

A. Reduced pressure zone (RPZ) backflow preventer (BFP) assemblies shall be provided in sizes to match that of line service piping or meter size.

B. The RPZ-BFP assembly shall consist of a pressure differential relief valve located between two positive seating check valves. The relief valve shall function automatically by sensing the pressure differential across the first check valve and discharge the backflow to the atmosphere should the check valve become damaged of fouled. The relief and check valves shall have replaceable seats and the check valves shall be provided with captured springs.

C. A full port ball valve in sizes through 2-inches and resilient seated OS&Y gate valves in sizes over 2-inches shall be on the inlet and outlet sides of the assembly, with a union, swivel coupling nut or flanges between the assembly and each valve. Unions and swivel nuts must be integral with the assembly or the valves.

D. The RPZ assembly shall be provided with three brass 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. Sizes through 2-inches shall have all test cocks in the vertical position. Relief valve vent ports shall have suitable connections for an air gap. When a meter or other device with bronze strainer, integral or attached, is not immediately upstream of the backflow preventer, a bronze strainer shall be provided between the inlet shut off valve and the RPZ through size 2-inches.

E. The RPZ assembly and shut off valve bodies shall be cast iron, coated inside and out with an NSF approved, fused epoxy coating and assembled with bolts that are resistant to electrolysis. All RPZ assembly interior and exterior

components shall be of materials equal in corrosion resistance to bronze and/or stainless steel to resist electrolysis.

F. Check valves shall have replaceable seats and shall be accessible by top entry only for maintenance and repair. The detector bypass line on the RPZ-BFP assembly shall be ¾-inch copper and have a bronze detector meter and a ¾-inch DCV-BFP complete with unions and shut off valves.

G. The RZP-BFP assembly shall be classified or listed by the Underwriters Laboratories, Factory Mutual Insurance and bear the ASSE seal (ASSE Standard 1049). The RZP-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) and ANSI/AWWA C511, Reduced-Pressure Principle Backflow Prevention Assembly.

PART 3 - EXECUTION

3.01 TESTING AND INSTALLATION

A. Backflow prevention assemblies shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the assemblies shall be repaired to the satisfaction of the Engineer before they are installed.

B. DDC-BFP Assembly: The DDC-BFP assembly shall be installed below ground in a vault, as shown on the Drawings.

C. RZP-BFP Assembly:

1. The RZP-BFP assembly shall be individually factory tested, shipped and installed as a unit.
2. The RZP-BFP assembly shall be installed above ground in an insulated enclosure as shown on the Drawings. Enclosure shall be aluminum or fiberglass construction with insulation designed to protect to -30 degrees F. Enclosure shall contain drain openings sized to accommodate the maximum discharge from the RPZ assembly and stainless-steel hasps to accept a lock. Enclosure shall be Watts Regulator Company Series Wattsbox or approved equal.

3.02 SHOP PAINTING

A. Ferrous surfaces of valves and appurtenances shall receive a coating of rust-inhibitive primer.

END OF SECTION 15150

SECTION 15250
MECHANICAL INSULATION AND HEAT TRACING

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 mechanical insulation. 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 15050, Basic Mechanical Materials and Methods.
2. Section 15060, Piping and Appurtenances.
3. Section 15400, Plumbing
4. Section 15891, Ductwork.
5. Section 15910, Ductwork Accessories.

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. Manufacturer's technical product data and installation instructions for each type of mechanical insulation:
    a. Manufacturer's product number.
    b. k-Value and thickness.
    c. Accessories included for each mechanical system requiring insulation.

2. Maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

3. Submit manufacturer's installation instructions.

B. (Not used)

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84, NFPA 255 method. Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150. Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

C. 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. ASTM, American Society for Testing Materials.
2. ASME, American Society of Mechanical Engineers.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. AWWA, American Water Works Association.
6. NFPA, National Fire Protection Association.
7. FM, Factory Mutual Engineering Corporation.
8. UL, Underwriters Laboratories, Inc.

1.04 STORAGE AND PROTECTION

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage.

Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Insulation products shall be manufactured by CertainTeed, Knauf, Johns Manville, Owens Corning, IMCOA, Pittsburgh-Corning, and Armstrong.

2.02 EQUIPMENT INSULATION

A. Equipment insulation shall be glass fiber board with factory applied foil-skrim-kraft
vapor barrier. Thermal conductivity shall not exceed 0.23 BTUin/hr/Ft^2/°F at 75 degrees F.

B. Equipment carrying conditioned air located in mechanical rooms or other service
areas shall be provided with 1-inch thick insulation of the type indicated below unless insulation has been factory-furnished by equipment manufacturer.

2.03 DUCTWORK INSULATION

A. Board type insulation material shall be fiberglass, minimum density of 3lbs/cu.ft., with factory applied foil-skrim-kraft 0.02 perm (maximum) vapor barrier. Thermal conductivity shall not exceed 0.23 BTUin/hr/Ft^2/°F at 75 degrees F. Board type insulation shall be provided on exposed rectangular ductwork.

B. Blanket type insulation material shall be fiberglass, minimum denisity 1 lb/cu.ft., and thermal conductivity of 0.27 BTUin/hr/ft2/°F at 75 degrees F mean temperature. Facing shall be factory applied 0.02 perm (maximum) vapor barrier, consisting of glass fiber scrim reinforced laminated facing of aluminum foil and Kraft paper. Blanket type insulation shall be provided on round ductwork and concealed rectangular ductwork.

C. Ductwork carrying conditioned (heated or cooled) or return air located in ceiling space, attic, mezzanine, concealed, or other non-conditioned areas shall be insulated with 2-inch thick insulation.

D. Ductwork carrying outside air to heating or air conditioning equipment shall be insulated with 2-inch thick insulation.

E. Ductwork carrying exhaust air located in ceiling space or attic shall be insulated with 1-inch thick insulation.

F. Unless noted otherwise as double wall ductwork on the drawings, the ductwork carrying conditioned (heated or cooled) air located outdoors or otherwise exposed to weather shall be insulated with 2-inch thick board type insulation. The insulation shall be covered with VentureClad 1579CW jacket as manufactured by VentureTape or equal.

G. Ductwork between wall louvers or roof vents and shut-off dampers shall be insulated with 2-inch thick insulation.

H. Unless noted otherwise on the Drawings, FRP ductwork shall not be insulated.

I. Unless noted otherwise on the drawings, the heating and ventilating ductwork located in the space being served by it shall not be insulated.

J. Provide staple, bands, wires, tape, anchors, corner angles, and similar accessories as recommended by insulation manufacturer for applications indicated.

K. Provide cements, adhesives, coatings, sealers, protective finishes, and similar compounds as recommended by insulation manufacturer for applications indicated.

2.04 DUCT LINER

A. Materials: Duct liner shall be glass fiber mat made from strong glass fiber bonded with a thermosetting resin. Side facing airstream shall be smooth, coated with acrylic coating with a flexible glass mat reinforcement. Thermal conductivity shall not exceed 0.24 BTUin/hr/Ft^2/°F at 75 degrees F. The duct liner shall be fungi and bacteria resistant.

B. Description: Ductwork (supply or return) as indicated on the Drawings shall be lined with 1-inch thick acoustical duct liner. The duct dimensions indicated on the Drawings are clear inside dimensions with liner. The shop fabrication cuts of the duct liner shall be coated with edge treatment products recommended by the manufacturer.

C. The duct liner shall be equal to Linacoustic RC as manufactured by Johns-Manville.

2.05 PIPE INSULATION

A. Materials (Indoor Hot Water and Tepid Water Piping)

1. Piping insulation shall be preformed glass fiber molded to cover pipe in two pieces with longitudinal joints. The insulation shall be covered with factory applied, all-service jacket with self-sealing lap strip. Thermal conductivity shall not exceed 0.23 BTUin/hr/Ft^2/°F at 75 degrees F.

2. Valve and fitting insulation shall be preformed glass fiber, covered with preformed PVC fitting covers. Thermal conductivity shall not exceed 0.23
BTUin/hr/Ft^2/°F at 75 degrees F.

B. Materials (Indoor Refrigerant, Cold Water, and Condensate Drain Piping)

1. Piping insulation shall be flexible elastomeric closed-cell type, slipped on the pipe prior to connection whenever possible. Where the slip-on technique is not possible, the insulation shall be pre-slit and snapped over the pipe with pre-applied adhesive. Butt joints shall be sealed with insulation manufacturer's adhesive or heat fuse method. Thermal conductivity shall not exceed 0.27 BTUin/hr/Ft^2/°F at 75 degrees F.

2. Fittings shall be insulated using fabricated fitting covers of flexible elastomeric closed-cell type insulation in accordance with the manufacturer's instructions. Join slit seams and mitered joints with manufacturer's adhesive or heat fuse method.

3. Provide PVC jacketing with solvent welded seams over insulation.

4. Insulation products shall be equal to Armaflex as manufactured by Armacell.

C. Materials (Outdoor Piping Exposed to Weather)

1. Premolded cellular glass thermal insulation shall be furnished in accordance with ASTM C 552 and C 1639 fabricated for standard pipe sizes, fittings, and valves.

2. Maximum thermal conductivity of 0.29 BTUin/hr/Ft^2/°F at 75 degrees F in accordance with ASTM C 177 and C 518.

3. Maximum water vapor permeability of 0.00 perm-in when tested in accordance with ASTM E 96.

4. Average density of 8.0 pounds per cubic foot.

5. Maximum Flame Spread Rating of 0 and Smoke-Developed Rating of 0 when tested in accordance with ASTM E84.

6. Utilize installation adhesives and joint sealants as recommended by the insulation manufacturer.

7. Furnish 30 gauge smooth Type 316 stainless steel jacketing over insulation retained by stainless steels bands of the same or thicker gauge. All jacketing seams shall be sealed weathertight with sealant suitable for outdoor installation.

8. Insulation products shall be equal to Pittsburgh Corning FOAMGLAS.

D. Pipe Insulation Thickness: Insulation thickness shall be 1 inch for pipes below 1.5 inches in diameter, 1.5 inches for pipes 1.5 inches to 3 inches in diameter, and 2inches for pipes 4 inches and above in diameter.

2.06 ELECTRIC HEAT TRACING FOR PIPING

A. Provide self-limiting heat trace cables where shown on the Drawings or described in these Specifications.

B. Cable shall have 16 AWG copper bus wire with self-regulating, semi-conductive core tinned copper braided shield over bus wire and core. Overjacket shall be modified polyolefin or fluoropolymer over shield. Cable shall provide temperature maintenance up to 150 degrees F. Cable shall be equal to Raychem Model BTV.

C. Provide all required electrical accessories, including power connection kits, splice kits, tee kits, lighted end seals, thermostats, aluminum or glass tape and other components required for a complete operating system for each heat trace service as scheduled herein. Cable and accessories shall be FM approved for insulation in NEC classified areas where indicated on the Heat Trace Schedule. Unless heat trace services are installed in NEC classified locations, all enclosures for electrical accessories shall be NEMA 4X rated. All components shall be UL-listed.

D. Thermostats shall be bulb type. Temperature range shall be adjustable from 25 to 150 degrees F.

E. Ambient-sensing thermostats for non-hazardous locations shall be equal to Model AMC-1A and hazardous locations shall be equal to Model AMC-1H as manufactured by Raychem. Line-sensing thermostats for non-hazardous locations shall be equal to Model AMC-1B and hazardous locations shall be equal to Model E507S-LS as manufactured by Raychem.

F. All chemical lines and emergency eye/wash shower lines shall be controlled by individual line-sensing thermostats. Potable and non-potable water lines may be grouped together and controlled by ambient-sensing thermostats.

G. Lighted end seals shall be equal to Raychem Model E-100-L-A. Splice or tee connection kit shall be equal to Raychem Model T-100. Single entry power connection kit shall be equal to Raychem, Model JBS-100. Multiple entry power/splice-tee connection kit shall be equal to Raychem Model JBM-100.

H. Outdoor design temperatures shall be 0° F.

I. Coordinate circuit sizing with available electrical circuits shown on the Electrical Drawings. All wiring and conduit from the junction boxes to the heat trace power connection kits shall be provided under this Division and installed in accordance with Division 16.

J. Provide pipe markers cautioning “ELECTRIC HEAT TRACING – SHOCK HAZZARD”.

K. Acceptable Manufacturers: Raychem, Thermon, and Chromalox.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which mechanical insulation is to be installed. Work shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure insulation serves its intended purpose.

1. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
2. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
3. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
4. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing and acceptance of tests.
5. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps

abutting each other.

6. Maintain integrity of vapor-barrier jackets on pipe insulation and protect to prevent puncture or other damage.
7. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

B. Insulate all of the services listed below. Where domestic service is called out, it is defined as piping concealed above ceilings and within walls or exposed in return air plenums and mechanical rooms.

1. Tepid water piping serving emergency fixtures.
2. Domestic potable water piping.
3. Domestic non-potable water piping.
4. Hot water piping.
5. Condensate drain piping.
6. Trap primer lines located in the ceiling space.
7. Refrigerant piping.

C. Insulate all piping, valves, and fittings that are heat traced in addition to those services specified herein.

3.03 ELECTRIC HEAT TRACING

A. Install heat tracing in accordance with the manufacturer's instructions prior to insulation.

B. Apply tracing cable around pipe, valves, and fittings as required to attain wattage densities specified herein. Do not spiral wrap pipe dimensions under 2-inches. Provide additional wattage for valves and fittings in accordance with the manufacturer's instructions.

C. Secure heat tracing cable to piping and components with glass tape. Provide aluminized Mylar heat transfer tape over and under heater and under insulation on plastic piping and valves.

D. Coordinate heat tracing installation with electrical and insulation work.

E. Where the multiple heat trace services are installed in a single area, each service shall be separately powered from an electrical junction box. Heat trace cable shall not be used as a means of power supply between separate heat trace services. Each heat trace service shall be provided with separate

power connection kits, end seals, thermostats, and accessories as scheduled within this Specification.

F. Do not locate thermostats in the direct sun.

3.04 INSTALLATION OF DUCTWORK INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

1. Install insulation materials with smooth and even surfaces.

2. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

3. Maintain integrity of vapor-barrier jackets on ductwork insulation and protect to prevent puncture and other damage.

4. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

5. Omit insulation on lined ductwork where internal insulation or sound absorbing linings have been installed, except as otherwise indicated.

B. Protect outdoor insulation exposed to weather by installing outdoor protective finish or jacketing as recommended by manufacturer.

C. Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

D. Insulation on the top surfaces of outdoor rectangular ductwork shall be sloped in both directions for proper drainage of storm water.

3.05 INSTALLATION OF EQUIPMENT INSULATION

A. Install equipment thermal insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

1. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

2. Maintain integrity of vapor-barrier on equipment insulation and protect to prevent puncture and other damage.
3. Do not apply insulation to equipment, breechings or stacks while hot.

4. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

5. Coat insulated surfaces with layer of insulated cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seam, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

6. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable.

7. Do not insulate manholes, handholes, cleanouts, ASME stamp, or manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

8. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

B. Protect outdoor insulation exposed to weather by installing weather-barrier mastic protective finish or jacketing as recommended by manufacturer.

END OF SECTION 15250

SECTION 15400
PLUMBING

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 all plumbing and associated appurtenances. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer'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 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.

C. Related Work Specified Elsewhere:

1. All earth and rock excavation, backfill, concrete masonry, concrete reinforcement, and construction joints required for plumbing work shall conform to the requirements specified under the applicable sections of the specifications.

2. Section 02200, Earthwork

3. Section 03200, Concrete Reinforcement and Dowelling

4. Section 03250, Concrete Joints

5. Section 04400, Masonry

6. Section 09912, Interior Painting

7. Section 15050, Basic Mechanical Materials and Methods

8. Section 15060, Piping and Appurtenances

9. Section 15530, Refrigeration Piping

10. Section 16050: Basic Electrical Materials and Methods

1.02 SUBMITTALS

A. 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 specifications, catalog data, descriptive matter, illustrations and diagrams.

2. Nameplates.

3. Foundations, installations and grouting.

4. Operating and maintenance instructions and parts lists.

5. Lubricants.

6. Special tools.

7. Bolts, anchor bolts and nuts.

8. Concrete inserts.

9. Sleeves.

B. Submit scaled plans and elevations of piping in areas of tight clearances for coordination of work by others subject to approval by the Engineer.

1.03 QUALITY ASSURANCE

A. 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. ANSI, American National Standards Institute.

2. ASTM, American Society for Testing Materials.

3. AWS, American Welding Society.

4. AWWA, American Waterworks Association.

5. UL, Underwriters Laboratory.

6. NEC, National Electric Code.

7. ASHRAE, American Society of Heating, Refrigeration and Air Conditioning Engineers.

8. OSHA, Occupational, Health and Safety Act.

9. NFPA, National Fire Protection Association.

1.04 QUALITY STANDARDS

A. Plumbing accessories of same type shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete and operable system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Contractor shall provide written certification that the accessories provided under this specification have 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 plumbing accessories manufacturer shall not be accepted.

1.05 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 PIPE AND FITTINGS

A. Domestic water (Copper Piping)

1. Maximum 2-1/2 inches: Copper tubing shall be hard-drawn conforming to the requirements of ASTM B 88, Type L or Type K.

2. Fittings shall be compression and hard-solder type as required. Flared type shall be Parker-Hannefin "Triple-Lock," American Brass

"Anaconda," Imperial Eastman "High-Seal" or equal. Hard solder fittings shall be wrought copper or cast brass conforming to the requirements of ASTM Designation B 62-74.

B. Drain, waste, and vent

1. Drain, waste and vent pipe shall be constructed of cast iron soil pipe in accordance with Section 15060.

2.02 VALVES

A. 2-inches and smaller shall be threaded or soldered, 2 1/2-inches and larger shall be flanged.

B. Gate Valves

1. 2-inches and smaller shall be Class 125, Type III, rated for a hydraulic working pressure of 125 psi.

2. 2 1/2-inches and larger shall be Class 125, Type II, outside-screw-and yoke type; rated for a hydraulic working pressure of 125 psi.

C. Check Valves

1. 2-inches and smaller shall have bronze trim and either cast iron or steel body, and be rated for a hydraulic working pressure of 125 psi.

2. 2 1/2-inches and larger shall be weight-loaded, have bronze trim and either cast iron or steel body and be rated for a hydraulic working pressure of 125 psi.
   a. Buried Lines: Mechanical joints.
   b. In Valve Chambers, Valve Pits, and Above Ground: Flanged Joints.

D. Ball Valves

1. 2-inches and smaller shall be bronze body with full port, rated for a hydraulic working pressure of 150 psi.

2. 2 1/2-inches and larger shall be shall be carbon steel or stainless steel body, stainless steel trim with full port, rated for a hydraulic working pressure of 150 psi.

E. Globe Valves

1. Globe valves 2-inches and smaller shall be bronze body with rising stem, screwed bonnet, integral bronze seat, renewable PTFE discs with screwed or solder joint ends. Valve shall be rated for a non-shock cold working pressure of 300 psi.

2. Globe valves 2-1/2-inches and larger shall be iron body, Class 125, flanged ends with bolted bonnet and non-rising stem. Valves shall be rated for a hydraulic working pressure of 150 psi.

F. Acceptable Manufacturers: Crane, Nibco, Stockham, Milwaukee, Watts, Apollo, Kitz.

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2.03 PIPING ACCESSORIES:

A. Nipples: FS WW-N-351; be of same type material as piping on which installed.

B. Unions for Copper Tubing: Brass or bronze, have either treaded or solder joint ends and conform to FS WW-U-516.

C. Unions for Steel Piping: FS WW-U-531.

D. Escutcheons: Polished chromium-plated pressed steel, split-hinged, locking type held in-place by either an internal tension spring or a set-screw; encompass sleeve or opening.

E. Bolts and Nuts: Machined brass, stainless steel, or galvanized carbon steel, and not smaller than 1/4-inch; bolts shall have hexagonal heads and nuts shall be hexagonal.

F. Solder for Solder-Jointed Tubing: 95 percent tin and 5 percent antimony. Flux shall be non-corrosive type conforming to NSF 61.

G. Strainers

1. Strainers in water lines shall have standard pattern, stainless steel baskets with standard perforations. Bodies shall be bronze for sizes 2-inch and smaller and cast iron for sizes 2-1/2-inch and larger. Strainers shall be equal to Watts Series 77 unless otherwise specified in other Sections of Division 22.

2. All strainers shall be of the same size as the piping in which they are installed. Provide dielectric union, if necessary, to isolate strainer from pipe material.

2.04 INSULATION

A. Insulation shall be in accordance with Sections 15250.

B. Insulate hot and cold-water piping systems per section 15250.

2.05 PIPING SPECIALTIES

A. Gaskets for Flanged Joints: Full-face, either neoprene, asbestos, or rubber: rubber gaskets: AWWA C302.

B. Vent Caps for Service Weight Soil Pipe: ASTM A 74.

C. Gaskets, Glands, and Bolts for Mechanical Joint Pipe and Fittings: AWWA C110, AWWA C112, and FS WW-P-421C.

D. Unions for Ferrous Pipe 3-inches in Diameter and Smaller: 150-pound steam-working-pressure zinc-coated malleable iron ground-joint type.

E. Unions for Ferrous Pipe 3-1/2-Inches in Diameter and Larger: 125-pound steam-working-pressure forged steel flange type, having cloth-inserted rubber gaskets 1/16-inch thick.

F. Couplings for Joining Hubless Cast Iron Pipe and Fittings: Cast iron housing conforming to ASTM A 48, Class 30A, have bitumastic coating, neoprene gasket conforming to ASTM C564 and 18-8 stainless steel bolts and nuts.

G. Solder for Solder-Jointed Tubing: 95 percent tin and 5 percent antimony; flux shall be non-corrosive.

H. Joint in Sanitary Lines Immediately Inside Exterior Wall and Joint Between Pipe of Dissimilar Metal: Dielectric insulating joint, union, or coupling.

I. Threaded joints shall have ANSI taper pipe threads conforming to NBS Handbook H.

J. Joint Compound: Either graphite, inert filer and oil, or polytetra-fluoroethylene tape.

K. Joints in cast iron soil pipe and fittings having a double seal, compression-type molded neoprene gasket shall have a modified hub to provide a positive seal.

2.06 FLASHING

A. Either soft-temper or cold-rolled copper weighing not less than 16 ounces per square foot or sheet lead weighing not less than four pounds per square foot.

2.07 TRAPS

A. "P" type, unless otherwise indicated; ASTM A 74. Traps for steel pipes and copper tubes shall have either recess drainage pattern or brass tube not less than 17 gauge.

B. Traps for PVC piping shall conform to ASTM D 2665 and shall be approved by NSF or IAPMO.

2.08 ESCUTCHEON

A. Polished chromium-plated pressed steel, split-hinged, locking type held in place by either an internal tension spring or a set-screw and encompass sleeve or opening.

2.09 PAINTING

A. Painting shall be in accordance with Section 09912, Interior Painting.

PART 3 - EXECUTION

3.01 PREPARATION

A. Early installation of buried drain piping may be required. All measurements shall be verified at the job site.

B. Avoid interferences with other trades.

3.02 WATER SUPPLY SYSTEM INSTALLATION

A. Install domestic water systems in accordance with AWWA standards and local codes applicable to water system installation.

B. Earthwork and trenching shall be in accordance with Division 2 of these Specifications.

C. Cut pipe and tubing accurately to measurements established at worksite; work pipe into place without springing and forcing. Install pipe with a fall towards either shut-off valve or lowest fixture.

D. Remove fins and burrs from piping. Apply lubricant to male threads only; threads shall be full cut, and not more than three threads on pipe shall remain exposed after tightening. Coat installed and tested exposed ferrous threads with one coat of non-toxic primer and oil paint.

E. Cut end of copper tubing square and remove burrs. Clean ends of tubing and apply a rosin type flux to outside surface of tubing ends and on recess inside of fittings. Insert tubing to full depth of fitting; then solder joints before soldering valves.

F. Install piping true to line and grade, and support and guide in a manner which will ensure indicated alignment. Installed piping shall clear obstructions, preserve headroom, keep openings and passageways clear, and not be in same trenches as sewer lines. Water supply system drawings are schematic; do not scale. Install unions on pipe ends immediately adjacent to valves, equipment, and tanks.

G. Valves shall be accessible for operation and servicing. Stems of installed valves shall not be below horizontal position. Valves which will be in furred spaces shall be accessible.

H. Make-up soldered-to-threaded connections with male thread-to-solder adapters.

I. After pipes have been installed, either cap or plug ends of pipes. Neither bury, furr-in, nor conceal piping before piping has been inspected and tested.

J. Provide access panels in finished walls for access to concealed valves, water hammer arrestors, and other devices requiring periodic maintenance.

K. Install insulation in accordance with Section 15250 of these Specifications.

L. Install backflow preventers in accordance with the manufacturer's directions and AWWA M14.

M. Dielectric Isolation

1. Wherever copper, brass, or bronze piping systems are connected to steel or iron piping systems, this connection shall be made with dielectric isolators. The dielectric isolators shall be so designed that non-ferrous piping materials shall be isolated by the use of Teflon or

nylon isolating materials made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection. All dielectric isolators shall be selected for the pressure of the system involved.

2. Dielectric isolators shall be Watts, Epco, Crane, or Maloney.

3.03 WATER SUPPLY SYSTEM TESTING

A. Test installed building water supply system in accordance with the International Plumbing Code.

B. Test piping that will be buried prior to concealment.

3.04 WATER SUPPLY SYSTEM DISINFECTING

A. Disinfect water systems in accordance with AWWA C651 and local codes applicable to water system disinfecting.

B. Before disinfecting system, flush line in a manner which will remove all extraneous materials.

C. Disinfect each section of new line before seeking acceptance of water supply system.

D. Either directly apply chlorine or mix water with calcium hypochlorite, chlorine gas, or calcium chloride. Retain solution in pipe for not less than 24 hours, then measure residual chlorine at ends of section and at other representative points; residual chlorine content is similar to that obtained from the source.

3.05 DRAINAGE SYSTEM INSTALLATION

A. Horizontal soil and waste pipe grades shall not be less than 1/4-inch per foot for 2-1/2-inch size and smaller, and not less than 1/8-inch per foot for 3-inch size and larger.

B. Changes in soil, waste, and drain pipe sizes shall be made with reducing fittings. Changes in direction shall be with either 45 degree wyes; long or short sweep 1/4, 1/6, 1/8, or 1/16 bends, or elbows.

C. Install trap at each fixture and piece of equipment connecting to the sanitary sewer system. Place trap as near to the fixture and equipment as possible; do not double-trap fixture.

D. Slip joints will be permitted only in trap seals or on inlet side of traps. Union connections shall be made with either tucker or hub drainage fittings.

E. Install and connect products in accordance with product manufacturer's printed installation instructions. Apply joint compound to threaded joints and tighten joints to a degree which will prevent leaks.

F. Interior of pipe, pipe fittings, drains, and cleanouts shall be clean before being installed and foreign substances on interior surfaces shall have been removed.

G. Cut ends of copper tube square and remove burrs. Clean outside of tube, where tube engages fittings and inside of fitting contacting tube, with an abrasive material before soldering. Tube and fittings shall not be annealed when making connections. Core solder will not be permitted. Apply heat uniformly around the tube and fitting joints in copper tube 2-1/2-inches and larger; use multiflame torch.

H. Join sections of hubless pipe with cast iron assemblies. Tighten threaded assemblies to 60 inch-pounds torque on each joint with a torque wrench specifically designed for the purpose. Retorque each screw not less than 24 hours after initial tightening.

I. Extend main vertical soil and waste stacks full size to roofline and above as vents, except where otherwise specifically indicated. Install vent pipes in roof spaces as close as possible to roof underside without forming traps in pipes; use fittings as required. If a circuit vent pipe from fixture, or line of fixtures, will be connected to a vent line serving other fixtures, connect at least 6-inches above floor level rim of highest fixture served. Grade vent and branch-vent pipe in a manner which will ensure that condensate will drain to vertical stack.

J. Services and structures to, and on, which sewer products will be affixed, place, and erected shall be capable of supporting those products.

K. Set pipe and fittings to line and grade before making-up joints.

L. Angular deflection of joints shall not exceed the recommendations of the pipe and fitting manufacturer. Should alignment require deflections to exceed those recommended, achieve indicated deflection with either special bends or short lengths of pipe.

M. Products to be buried shall rest on excavation bottom; recess lower quadrant of pipe and fittings and ends thereof into excavation bottom. Bells shall face upstream. Space between inside of bells and outside of spigots shall be even all around. Ring joints shall be made-up only after retaining

groove has been cleaned and only after ring and groove have been lubricated.

N. Excavations shall be free from water and extraneous material immediately before sewer products to be buried are placed therein. Bottoms of trenches shall have been shaped to support bottom quadrant of pipe and fittings and ends thereof. Should rock and material unsuitable to support product exist at design elevation, excavate 8-inches below design elevation and backfill additionally excavated space with sand.

O. Secure products not to be buried to hangers, supports, and anchors. Tighten bolts and nuts of flanged joints to a degree which will prevent leaks.

P. Seal open ends of products at end of work period and in a manner which will prevent water and foreign materials from entering; remove seals when work resumes.

Q. Install escutcheons where exposed piping, bare or insulated, passes through floors, wall, and ceilings. Fasten escutcheons to pipe or pipe covering.

R. Pipe sleeves for pipes passing under footings or through foundation walls shall be Schedule 40 ductile iron pipe extending one foot beyond either face of the footing or wall.

S. Solvent-Welded PVC Joints: All solvent-welded PVC joints shall be installed in accordance with ASTM 2855.

3.06 FLOOR DRAIN INSTALLATION

A. Coordinate floor drain locations and installation elevations with the Structural and Architectural Drawings.

B. Install floor drains at the local low point in the floor slab.

C. Install floor drains with membrane clamping rings if the floor slab contains a membrane.

D. Protect the floor drain during the floor slab pour to prevent extraneous material from entering the drain or waste piping. Cover during the remainder of the construction to prevent blockage with construction debris.

3.07 CLEANOUT INSTALLATION

A. Install cleanout tee with screw plug on each building drain.

B. Install outside cleanouts at grade centered in an 18 x 18 x4-inch thick concrete pad. Top of pad shall be at grade elevation unless otherwise noted.

3.08 DRAINAGE SYSTEM INSPECTION AND TESTING

A. Test installed sanitary drainage and building sewer systems with water and air in accordance with the International Plumbing Code.

B. If system exhibits leaks, repair leaks and retest system until system exhibits no leaks.

C. Test piping that will be buried prior to concealment.

3.09 DRAINAGE SYSTEM CLEANING

A. Remove foreign material from product surfaces, but do not remove manufacturers' labels until Project has been accepted by the Engineer; then remove labels.

B. Repair pipe coating that may have been damaged during pipe insulation.

END OF SECTION 15400

SECTION 15430
HYDROPNEUMATIC TANKS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the requirements for the design, fabrication, delivery, installation, and testing of hydropneumatic tanks for the domestic water system, as shown on the Drawings and described in these Specifications.

B. Related Sections:

1. 09900 - Painting
2. 15050 – Basic Mechanical Materials and Methods
3. 15060 Piping and Appurtenances
4. 15100-Valves and Appurtenances.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. ASME Boiler and Pressure Vessel Code

B. NSF International:

1. NSF/ANSI-61: Drinking Water System Components
2. NSF-61 Annex G: Lead Content

C. Other relevant codes and standards as required by local authorities having jurisdiction.

1.03 SUBMITTALS

A. Manufacturer's Data: Provide manufacturer's cut sheets and specifications for the hydropneumatic tanks, including tank dimensions, volume, working pressure rating, material of construction, ASME certification, and NSF certification.

B. Shop Drawings: Provide shop drawings detailing the tank's dimensions, connection locations, accessories, and installation instructions.

C. Manufacturer's U-1 Report: Provide U-1 report if ASME plate does not indicate minimum wall thickness. The U-1 report is used to determine the

original head and shell thickness. The measured thickness is compared to the U-1 indications.

D. Product Certifications: Provide copies of ASME and NSF certifications.

E. Operating and Maintenance Manuals: Provide complete operating and maintenance instructions for the hydropneumatic tanks.

PART 2 - PRODUCTS

2.01 HYDROPNEUMATIC TANKS

A. Manufacturer: The basis of design for hydropneumatic tanks is Wessel Model FXA-4000. Hanson Tank and Highland Tanks are acceptable alternate manufacturers.

B. General:

1. Provide ASME rated, pre-charged, vertical style bladder tanks with bottom system (water) connection.

2. Tanks shall be designed, constructed, and tested in accordance with ASME Boiler and Pressure Vessel Code.

3. Tanks shall be certified to meet NSF/ANSI-61 and NSF-61 Annex G for drinking water use.

C. Materials:

1. Steel shell with red oxide exterior primer.
2. FDA approved liner of polypropylene or epoxy.
3. Replaceable butyl bladder, minimum 0.10 inch thick.

D. Performance & Configuration:

1. Tank rated pressure: 125 PSIG

2. Tank rated temperature: 240°F

3. Maximum working pressure: 80 PSIG

4. Minimum working pressure: 40 PSIG

5. Acceptance volume: 430 gallons

6. Total tank volume: 1,018 gallons

7. Maximum tank diameter: 6’-0”

8. Maximum tank height including pedestal: 7’-6”

E. Accessories:

1. Tire valve style charging connection.

2. Bronze or malleable iron water connection.

3. Auxiliary gauge/pressure switch connection.

4. Lifting ring(s).

5. Steel floor support skirt.

6. Flanged manway

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install hydropneumatic tanks according to manufacturer's written instructions and the approved shop drawings.

B. Ensure tank is installed on a suitable support structure and anchored securely.

C. Connect piping to the tank in accordance with applicable plumbing codes and standards.

3.02 TESTING

A. Test the hydropneumatic tank and associated piping system for leaks in accordance with applicable codes and standards.

B. Verify the tank's pre-charge pressure and adjust, as necessary.

3.03 CLEANING AND DISINFECTION

A. Clean and disinfect the tank and associated piping system in accordance with applicable codes and standards.

3.04 PAINTING

A. Prepare unfinished tank for finish painting and provide finish coating in accordance with Section 09900.

3.05 FINAL ACCEPTANCE

A. Upon completion of installation and testing, demonstrate to the Owner or Owner's representative that the hydropneumatic tanks are functioning correctly and meeting the specified requirements.

END OF SECTION 15430

SECTION 15440
SHOWER AND EYEWASH FIXTURES

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 installation of all emergency shower and eyewash fixtures. All equipment shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer'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 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.

C. Related Work Specified Elsewhere:

1. Section 15050 Basic Mechanical Materials and Methods
2. Section 15250 Plumbing Insulation and Heat Tracing
3. Section 15400 Plumbing

1.02 SUBMITTALS

A. 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 and installation instructions.

1.03 QUALITY ASSURANCE

A. 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. ANSI, American National Standards Institute.
2. NEC, National Electric Code.
3. OSHA, Occupational Safety and Health Act.
4. NFPA, National Fire Protection Association.

1.04 QUALITY STANDARDS

A. The emergency shower and eyewash fixtures 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 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.

C. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the pump manufacturer shall not be accepted.

D. Acceptable Manufacturers:

1. Speakman, Bradley, Haws, and Guardian

1.05 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 EMERGENCY SHOWER AND EYEWASH FIXTURES

A. Drench Shower/Eyewash – Heat Traced and Insulated

1. Provide heat traced and insulated combination drench shower/eyewash units with 8-inch diameter plastic shower, 2 plastic spray outlets with automatic flow control and flip-top dust caps, stay-

open shower valve with triangular pull rod, eye/face wash valve activation with push handle, 1-1/4 IPS inlet and drain, and floor flange.

2. Heat trace cable shall be self-regulating type with braided metal shield, NEMA 4X water-tight and dust-tight junction box, 120 VAC.

3. The unit shall have closed cell rubber foam insulation.

4. ANSI/ISEA Z358.1 certified.

5. Provide the identification sign designed for wall mounting to read “EMERGENCY SHOWER AND EYE WASH”.

6. Shower/eyewash shall be equal to Speakman model SE-7000 for bottom supply.

2.02 EMERGENCY FIXTURE – FLOW SWITCH – THERMAL DISPERSION TYPE

A. Provide thermal dispersion type flow switch in the emergency fixture water supply loop.

B. The process connection shall be 3/4-inch MNPT with a standard “U” length suitable for mounting in a 3/4-inch threaded tee. The unit shall be designed to mount in horizontal piping in a side mounted configuration.

C. Contacts: SPDT 5 amp resistive at 120 VAC.

D. Response Time: Unit shall guarantee less than 10 seconds response time for the line sizes, flow rates, and other conditions as installed in this application.

E. Power: 120 VAC.

F. Materials of Construction

1. Wetted Parts: 316 stainless steel.

2. Electronics Enclosure: Cast aluminum with epoxy coating, suitable for outdoor service.

G. Calibrate the flow switches to generate alarm based on eyewash flow. See Division 16 for remote reporting of flow activation alarm.

H. Acceptable Manufacturers: FCI (Series FLT) or Magnetrol (Thermatel Model TD2)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installation of fixtures.

C. Examine walls and floors for suitable conditions where fixtures are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and the pertinent codes and regulations, the original design, and the referenced standards.

B. Fasten plumbing fixtures securely to the supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

C. Seal fixtures to floors using silicone sealant as specified in Division 7. Match sealant color to fixture color.

3.03 FIELD QUALITY CONTROL

A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

B. Inspect each installed unit for damage. Replace damaged fixtures.

3.04 ADJUSTING

A. Adjust water pressure at shower valves, and flush valves to provide proper flow and stream.

B. Clean fixtures using manufacturer's recommended cleaning methods and materials.

END OF SECTION 15440

SECTION 15530
REFRIGERATION PIPING

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 refrigeration piping system. 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. The refrigerant piping is used for air conditioning applications and includes the following:

1. Pipes, tubing, fittings and specialties.
2. Special duty valves.
3. Refrigerants.

D. Related Work Specified Elsewhere:

1. Section 02000, Site Work.
2. Section 15050, Basic Mechanical Materials and Methods.
3. Section 15740, Ductless Split Systems.
4. Section 15250, Mechanical Insulation and Heat Tracing.

E. Products installed but not furnished under this Section include pre-charged tubing, refrigerant specialties, and refrigerant accessories furnished as an integral part of or separately with packaged air conditioning equipment.

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 the following products:
    a. Each type valve specified.
    b. Each type refrigerant piping specialty specified.

2. Maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

3. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment

4. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under paragraph 1.03 below.

B. (Not used)

1.03 QUALITY ASSURANCE

A. Qualify brazing processes and brazing operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. 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. ASTM, American Society for Testing Materials.
2. ASME, American Society of Mechanical Engineers.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ASHRAE, American Society of Heating and Refrigeration Architectural Engineers.
6. NFPA, National Fire Protection Association.

7. FM, Factory Mutual Engineering Corporation.

8. UL, Underwriters Laboratories, Inc.

9. ARI, Air Conditioning and Refrigeration Institute.

PART 2 - PRODUCTS

2.01 PIPING AND TUBING MATERIALS

A. Refer to Part 3 for identification of systems where the below specified pipe and fitting materials are used. Refrigerant piping shall be in accordance with ANSI B31.5 and ANSI/ASHRAE Standard 15 Safety Code for Refrigeration.

1. Copper Tubing: ASTM B 280, Type ACR, hard-drawn straight lengths, and soft-annealed coils, seamless copper tubing. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.

2. Copper Tubing: ASTM B 88, Type L, hard-drawn straight lengths, and soft-annealed coils, seamless copper tubing.

B. Fittings shall be wrought-copper in accordance with ANSI B16.22, streamlined pattern. Brazing filler materials shall be in accordance with AWS A5.8, Classification BAg-1, Silver.

C. Complete valve assembly shall be UL-listed and designed to conform to ARI 760.

1. Globe: 450 psig maximum operating pressure, 275o F maximum operating temperature; cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through pattern, with solder-end connections.

2. Check Valves smaller than 7/8 inch: 500 psig maximum operating pressure, 300o F maximum operating temperature; cast brass body, with removable piston, Teflon seat and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.

3. Check Valves 7/8 inch and larger: 450 psig maximum operating pressure, 300o F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

4. Solenoid Valves: 250° F temperature rating, 400 psig working pressure; forged brass with Teflon valve seat, two-way straight through pattern, and solder-end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz normally closed holding coil.

5. Evaporator Pressure Regulating Valves: Pilot-operated, forged brass or case bronze; complete with pilot operator, stainless steel bottom spring, pressure gage tappings, 24 volts DC, 50/60 Hz, standard coil; and wrought-copper fittings for solder-end connections.

6. Thermal Expansion Valves: Thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line, and an external equalizer line.

2.02 REFRIGERANT PIPING SPECIALTIES

A. Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to ARI 760.

1. Strainers: 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder-end connections.

2. Moisture/liquid Indicators: 500 psig maximum working pressure, 200° F maximum operating temperature; forged brass body with replaceable polished optical viewing window and solder-end connections.

3. Filter-driers: 500 psig maximum working pressure; steel shell, flange ring and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder-end connections. Furnish complete with replaceable filter-drier core kit, including gaskets as follows:

    a. Standard capacity desiccant sieves to provide micronic filtration.
    b. High capacity desiccant sieves to provide micronic filtration and extra drying capacity.

4. Suction Line Filter-Drier: 350 psig maximum working pressure, 225° F maximum operating temperature; steel shell and wrought copper fittings for solder-end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

5. Suction Line Filters: 500 psig maximum working pressure; steel shell, flange ring and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder-end connections. Furnish complete with replaceable filter core kit, including gaskets as follows:

   a. Flanged unions shall be rated for 400 psig maximum working pressure, 330o F maximum operating temperature; two brass tailpiece adapters for solder-end connections to copper tubing; flanges for 7/8 inch through 1-5/8 inch unions shall be forged steel, and for 2-1/8 inch through 3-1/8 inch shall be ductile iron; four plated steel bolts, with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory-applied rust-resistant coating.
   b. Flexible connectors shall be rated for 500 psig maximum working pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder-end connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length.

6. Refrigerant shall be R-32 or R-454B.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation.

B. (Not used)

3.02 PIPE APPLICATIONS

A. Use Type L or Type ACR drawn copper tubing with wrought copper fittings and brazed joints above ground, within building. Use Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground and within slabs. Mechanical fittings of the crimp or flair type are not permitted.

B. Install annealed temper tubing in pipe duct. Vent pipe duct to the outside.

C. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Cleaning article below.

3.03 PIPING INSTALLATIONS

A. Install refrigerant piping in accordance with ASHRAE Standard 15- The Safety Code for Mechanical Refrigeration.

B. Install piping in as short and direct arrangement as possible to minimize pressure drop.

1. Exposed piping shall be installed at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

2. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

C. Install piping for minimum number of joints using as few elbows and other fittings as possible.

1. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

2. (Not used)

D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

1. Unions shall be provided to allow removal of solenoid valves, pressure regulating valves, expansion valves and at connections to compressors and evaporators.

2. Flexible connectors shall be provided at the inlet and discharge connection of compressors.

E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls or ceilings, sized to permit installation of full thickness insulation.

1. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

2. Install piping tight to slabs, beams, joists, columns, walls and other

permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

3. Locate groups of pipe parallel to each other, spaced to permit applying insulation and servicing of valves.

F. Insulate suction lines. Liquid lines are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

2. (Not used)

G. Install branch tie-in lines to parallel compressor equal length, and pipe identically and symmetrically.

H Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.

2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate fro the suction gas and return to the compressor in damaging slugs.

3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.

4. Liquid lines may be installed level.

J. Penetrations shall be as follows:

1. Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.

2. Where pipes pass through fire rated wall, partitions, ceilings and

floors, maintain the fire rated integrity.

K. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

L. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.

1. Install moisture/liquid indicators in lines larger than 2-1/8-inch OD, using a bypass line.

2. (Not used)

3.04 HANGERS AND SUPPORTS

A. Hanger, supports, and anchors are specified in Section 15060, Piping and Appurtenances. Conform to the table below for pipe attachments and maximum spacing of supports:

1. Adjustable steel clevis hanger for individual horizontal runs less than 20 feet in length.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

3. Pipe rollers compete supports for multiple horizontal runs, 20 feet or longer supported by a trapeze.

4. Spring hangers to support vertical runs. Support vertical runs at each floor.

5. Hangers shall be provided with the following minimum rod sized and maximum spacing:

Nom. Pipe Size	Max. Span - Ft.	Min.Rod Size - Inches
Up to 1”	7	1/2
1-½”	9	1/2
2”	10	1/2

B. (Not used)

3.05 PIPE JOINT CONSTRUCTION

A. Brazed joints shall comply with the procedures contained in the AWS Brazing Manual.

1. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.

2. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

3.06 VALVE INSTALLATIONS

A. Install refrigerant valves where indicated and in accordance with manufacturer's instructions.

1. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators and elsewhere as indicated.

2. Install a full sized, 3-valve bypass around each drier.

3. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.

    a. Electrical wiring for solenoid valves is specified in Division 16, Electrical.

4. Thermostatic expansion valves my be mounted in any position, as close as possible to the evaporator.

    a. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
    b. Install the valve in such a location so that the diaphragm case is warmer that the bulb.
    c. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Don not mount bulb in a trap or at the bottom of the line.
    d. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.

5. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

3.07 FIELD QUALITY CONTROL

A. Inspect, test and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI.

1. Repair leaking joints using new materials and retest for leaks.

3.08 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fittings using the following cleaning procedure:

1. Remove coarse particles of dirt and dust by drawing a clean, lint-less cloth through the tubing by means of a wire or an electrician's tape.

2. Draw a clean, lint-less cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.

3. Draw a clean, lint-less cloth saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.

4. Finally, draw a clean, dry, lint-less cloth thorough the tube or pipe.

3.09 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping system in accordance with the requirements of Section 15050.

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.10 CHARGING

A. Charge system using the following procedure

1. Install core in filter dryer after leak test but before evacuation.

2. Evacuate refrigerant system with vacuum pump; until temperature of

35° F is indicated on vacuum dehydration indicator.

3. During excavation, apply heat to pocket, elbows and low spots piping.
4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

END OF SECTION 15530

SECTION 15740
DUCTLESS SPLIT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes ductless split system air conditioner and accessories.

1.2 SUBMITTALS

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Product Data, Submit the following:

1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.

2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.

3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.

4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.

5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years' experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Protect units from weather and construction traffic by storing in dry, roofed location.

1.6 WARRANTY

A. Furnish five-year manufacturer warranty.

1.7 QUALITY ASSURANCE

A. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210 and bear the ARI label.

1.8 EXTRA MATERIALS

A. Furnish one set of filters for each unit.

PART 2 – PRODUCTS

2.1 PACKAGED OUTDOOR UNITS

A. Manufacturers:

1. Carrier or equal by Mitsubishi or Trane. See Drawings for design basis model number.

2.2 INDOOR UNIT

A. General:

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes will be charged with dry air instead of R-32 or R-454B before shipment from the factory.

B. Unit Cabinet:

1. The casing shall have a white finish.

2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.

3. Furnish a separate back plate that secures the unit firmly to the wall.

C. Fan:

1. The evaporator fan shall be an assembly with a line-flow fan direct driven by a single motor.

2. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.

3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).

4. A motorized air sweep flow louver shall provide an automatic change in airflow by directing the air up and down to provide for uniform air distribution.

5. The indoor fan shall consist of three (3) speeds, High, Medium and Low.

D. Filter:

1. Return air shall be filtered by means of an easily removable washable filter.

E. Coil:

1. The evaporator coil shall be of nonferrous construction with smooth plate fins on copper tubing.

2. The tubing shall have inner grooves for high efficiency heat exchange.

3. All tube joints shall be brazed with phoscopper or silver alloy.

4. The coils shall be pressure tested at the factory.

5. A condensate pan and drain shall be provided under the coil.

F. Electrical:

1. The unit electrical power shall be 115 volts, 1 phase, 60 hertz.

2. The system shall be capable of satisfactory operation within voltage limits of 103 volts to 127 volts.

3. The indoor unit shall not have any supplemental electrical heat elements.

G. Control:

1. The unit shall have a wireless controller to perform input functions necessary to operate the system.

2. The controller shall consist of a Power On/Off switch, Mode Selector, Temperature Setting, Timer Control, Fan Speed Select and Auto Vane selector.

3. The indoor unit shall perform Self-diagnostic Function, Test Run switching and Check Mode switching.

4. Temperature changes shall be by 2°F increments with a range of 65 - 87°F.

5. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless controller, providing emergency operation and controlling the outdoor unit.

6. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.

7. The system shall be capable of automatically restarting when power is restored after power interruption.

8. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and System/Mode function switching.

2.3 OUTDOOR UNIT

A. General:

1. The outdoor unit is designed specifically for use with indoor units. These units are equipped with a circuit board that interfaces with indoor unit and perform all functions necessary for operation. The unit must have a powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

B. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

C. Fan:

1. The unit shall be furnished with a direct drive propeller type fan.

2. The motor shall have inherent protection, be permanently lubricated bearings.

3. The fan motor shall be mounted for quiet operation.

4. The fan shall be provided with a raised guard to prevent contact with moving parts.

5. The outdoor unit shall have a horizontal discharge airflow.

D. Coil:

1. The condenser coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

2. The coil shall be protected with an integral metal guard.

3. Refrigerant flow from the condenser shall be controlled by means of a metering orifice.

E. Compressor:

1. The compressor shall be of a high performance hermetic, inverter driven type.

2. The outdoor unit shall have an accumulator.

3. The compressor will be equipped with an internal thermal overload.

4. The outdoor unit must have the ability to operate with a maximum height difference of 25 feet and have refrigerant tubing length of 49 feet between indoor and outdoor units without the need for line size changes, traps or additional oil.

5. The compressor shall be mounted to avoid the transmission of vibration.

6. Heat pump units shall have reversing valve for auto cool/heat changeover.

F. Electrical:

1. The unit electrical power shall be per the equipment schedules on the drawings.

2. The unit shall be controlled by the BACNET compatible microprocessor.

3. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify concrete pad for condensing unit is ready for unit installation.

3.2 INSTALLATION - AIR HANDLING UNIT

A. Install condensate piping with trap and route from drain pan through wall for disposal.

B. Install components furnished loose for field mounting.

3.3 INSTALLATION - CONDENSING UNIT

A. Install units on concrete pads.

B. Install refrigerant piping from indoor unit to condensing unit. Install refrigerant specialties furnished with unit.

C. Evacuate refrigerant piping and install initial charge of refrigerant.

D. Install electrical devices furnished loose for field mounting.

E. Install control wiring between indoor unit, condensing unit, and field installed accessories.

F. Install connection to electrical power wiring.

3.4 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Wash filter media at Substantial Completion.

END OF SECTION 15740

SECTION 15830
HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Propeller fans.
2. Inline fans.

1.2 SUBMITTALS

A. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

B. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit fan manufacturer’s instructions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.4 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA Publication 211

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.

B. Installer: Company specializing in performing Work of this section with minimum three years of experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Furnish one-year manufacturer's warranty for fans.

PART 2 - PRODUCTS

2.1 PROPELLER FANS

A. Manufacturers: Equal to Greenheck.

B. Construction:

1. Impeller: Shaped steel or steel reinforced aluminum blade with hub, statically and dynamically balanced, keyed and locked to shaft, directly connected to motor or furnished with V-belt drive.

C. Accessories: OSHA Safety Guard, backdraft damper.

2.2 INLINE EXHAUST FANS

A. Manufacturers: Equal to Greenheck.

B. Direct drive inline centrifugal fan with non-overloading, backward inclined wheel constructed of aluminum. AMCA Standard 204, 211 and 311 certified. Blades shall be securely riveted or welded to a heavy gauge back plate and wheel cone. Motor shall be electronically commutated with mounted potentiometer dial. Motor shall be speed controllable down to 20 percent of full speed. Motor shall be a minimum of 85% efficient at all speeds. Housing shall be constructed of galvanized steel.

C. Accessories: NEMA 1, toggle, junction box mounted and wired, backdraft damper.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

A. Secure curb cap with stainless steel lag screws to roof curb.

B. Suspended Inline Fans: Install flexible connections between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one-inch flex between ductwork and fan while running.

C. Install backdraft dampers on discharge of exhaust fans as indicated on Drawings.

3.3 CLEANING

A. Vacuum clean inside of fan cabinet.

3.4 PROTECTION OF FINISHED WORK

A. Do not operate fans until ductwork is clean, and fan has been test run under observation.

END OF SECTION 15830

SECTION 15890
AIR DISTRIBUTION DEVICES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Grilles
2. Registers
3. Diffusers

1.02 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 REFERENCES

A. Standards:

1. National Fire Protection Association (NFPA):
   a. Standard 255, Test Methods for Surface Burning Characteristics of Building Materials.

2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   a. ASHRAE Std 70, Method of Testing for Rating the Performance of Air Outlets and Inlets; 1991

3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

4. SMACNA HVAC Duct Construction Standards - Metal and Flexible; 1995, Second Edition with Addendum No. 1.

1.04 SUBMITTALS

A. All submittals shall comply with the requirements of Division 1 GENERAL REQUIREMENTS and Section 15050 BASIC MECHANICAL MATERIALS AND METHODS.

B. Product Data: Data shall be submitted on the following items:

1. Grilles
2. Registers
3. Diffusers

C. Equipment to Owner:

1. Two special tools for security screws and attachments.

1.05 QUALITY ASSURANCE

A. Manufacturers:

1. Products scheduled on the drawings are the basis of design to establish performance criteria and size. Subject to compliance with these specifications and the drawings, the products of the following manufacturers are acceptable.
   a. Carnes
   b. Krueger
   c. Metal Aire
   d. Price
   e. Titus
   f. Tuttle & Bailey
   g. Or equal

1.06 DELIVERY, STORAGE AND HANDLING

A. Shipping:

1. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

3. Deliver spare parts to the Owner after completion of work.

B. Receiving:

1. Inspect and inventory items upon delivery to site.

2. Store and safeguard equipment, material and spare parts in accordance with manufacturers' written instructions.

PART 2 – PRODUCTS

2.01 GENERAL

A. Finish:

1. Grilles, registers, and diffusers shall be provided with a factory applied white baked enamel finish unless indicated otherwise, herein or on the drawings. Aluminum grilles and registers which are so scheduled shall be factory etched to a satin finish and coated with a clear lacquer.

B. Mounting:

1. Coordinate mounting with surface/assembly in which mounted and provide manufacturer's standard frame and border to application.

C. Grilles, Registers, and Diffusers:

1. Ceiling Supply Diffusers: Supply air diffuser shall be aluminum or steel (see air device schedule) with 3-cone louvered face; 12"x12" or 24"x24" frame (see air device schedule) and border for lay-in ceiling mounting; aluminum back pan with integrally drawn neck for flexible duct connection (size as noted).

2. Double Deflection Registers: Supply air register shall be aluminum with double deflecting individually adjustable horizontal and vertical vanes and flat margin with gasket. Vertical vanes shall be in front; vane spacing shall be 3/4" on center. Provide with steel opposed blade dampers key operated from face of register.

3. Eggcrate Grilles: Grilles shall be aluminum with 1/2" x 1/2" x 1/2" eggcrate grid, 1" W border and frame. Eggcrate grilles installed in 24"x24" lay-in ceilings shall have 24"x24" border with 22"x22" face and neck. Surface and sidewall mounted grilles shall have neck size as noted on plans.

PART 3 – EXECUTION

3.01 STORAGE

A. Air distribution devices shall be stored on wooden pallets or rails, covered by 6-mil polyethylene cover, taped in place, until ready for installation.

3.02 INSTALLATION

A. Air distribution devices installation shall be per manufacturer's instructions for specific application and these Construction Documents. Coordinate frame and border type with assembly in which installed.

B. Air distribution devices mounted in walls shall be secured to ductwork with sheet metal screws.

C. Air distribution devices sized to fit ceiling grid system shall be supported from grid system. Air distribution devices not sized to fit ceiling grid systems shall be secured to ductwork with sheet metal screws.

D. Provide spin-in fitting with manual balancing damper, less extractor scoop, at take-off for each new air device.

END OF SECTION 15890

SECTION 15891
DUCTWORK

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 rectangular, round and flat-oval ducts and plenums. The ducts shall be supplied for heating, ventilating and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage. All systems shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the Fabricator'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 07920, Joint Sealants.
2. Section 15050, Basic Mechanical Materials and Methods.
3. Section 15250, Mechanical Insulation.
4. Section 15910, Ductwork Accessories.
5. Section 15890, Air Distribution Devices.
6. Section 15990, Testing, Adjusting and Balancing of HVAC Systems.

D. Definitions:

1. Sealing Requirements: For the purposes of duct system sealing requirements specified in this Section the following definitions apply:
    a. A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
    b. Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to duct; access door and access panel

frames and jambs; duct, plenum, and casing abutments to building structures.

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 including details of construction relative to material, dimensions of individual components, profiles, and finishes for the following items:
    a. Duct liner.
    b. Sealing materials.
    c. Fire-stopping materials.

2. Shop drawings from duct fabrication shop, drawn to scale not smaller than ¼ inch equals 1 foot, on drawing sheets same size as the Contract Drawings detailing:
    a. Fabrication, assembly and installation details for metal and glass fiber ducts, including plans, elevations, section, details of components and attachments to other Work.
    b. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled.
    c. Fittings.
    d. Reinforcing details and spacing.
    e. Seam and joint construction details.
    f. Penetrations through fire-rated and other partitions.
    g. Terminal unit, coil and humidifier installations.
    h. Hangers and supports, including methods for building attachment, vibration isolation and duct attachment.

3. Coordination drawings for ductwork installation shall show the following:
    a. Coordination with ceiling suspension members.
    b. Spatial coordination with other systems installed in the same space with the duct systems.
    c. Coordination of ceiling and wall mounted access doors and panels required to provide access to dampers and other operating devices.
    d. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

4. Record drawings including duct systems routing, fittings, details, reinforcing, support and installed accessories and devices.

5. Maintenance data for volume control devices, fire dampers and smoke dampers.

1.03 QUALITY ASSURANCE

A. 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. ASTM, American Society for Testing Materials.
2. ASME, American Society of Mechanical Engineers.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. NFPA, National Fire Protection Association.
6. UL, Underwriters Laboratories, Inc.
7. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers.
8. SMACNA, Sheet Metal and Air Conditioning Contractors' National Association.
9. TIMA, Thermal Insulation Manufacturer's Association.
10. ICBO, International Conference of Building Officials.

1.04 QUALITY STANDARDS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been designed in accordance with these specifications and is suitable for these service conditions.

1.05 STORAGE AND HANDLING

A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.

B. Store and handle sealant fire-stopping materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperature, contaminants or other causes.

C. Deliver and store stainless steel sheet with mill-applied adhesive protective paper, maintained through fabrication and installation.

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 METAL DUCT MATERIALS

A. Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.

1. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

2. Aluminum: ASTM B209 Aluminum Sheet Alloy 3003-H14 with connection and bar stock constructed of Aluminum Alloy 6061-T6 or equal.

3. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.

4. Stainless Steel: ASTM A 480, Type 316, sheet form, with No. 4 finish on exposed surface for ducts exposed to views; Type 304, sheet form, with No. 1 finish for concealed ducts.

B. Reinforced shapes and plates, unless otherwise indicated, shall be galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless-steel ducts provide reinforcing of compatible materials.

C. Tie-rods shall be galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer that 36 inches.

2.02 DUCT LINER FOR METAL DUCT

A. Duct liners shall comply with NFPA Standard 90A and TIMA Standard AHC-101.

1. Materials: ASTM C 1071, Type II, with coated surface exposed to air stream to prevent erosion of glass fibers.

2. Thickness: 1- inch.

3. Density: 3 pounds.

4. Thermal Performance: K-Factor shall be equal to 0.28 or better, at a mean temperature of 75oF.

5. Fire Hazard Classification: Flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM C 411.

6. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C 916.

7. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.

    a. Fastener pin length shall be as required for thickness of insulation and without projecting more that 1/8-inch into the air stream.
    b. Adhesive for attachment of mechanical fasteners shall comply with Fire Hazard Classification of duct liner system.

2.03 SEALING MATERIALS

A. Joint and Seam Sealants: The term sealant used in this Section is not limited to material of adhesive or mastic, but also includes tapes and combinations of open weave fabric strips and nature mastics.

1. Joint and Seam Tape: 2-inch wide, glass-fiber-fabric reinforced.

2. Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant; formulated with a minimum of 75 percent solids.

3. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

4. Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors having fire-resistance ratings indicated as established by testing identical

assemblies per ASTM E 814 by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.

2.04 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4-inch thick.

B. Hangers: Galvanized sheet steel or round, uncoated steel, threaded rod.

C. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

D. Straps and Rod Sizes: Conform with Table 4-1 SMACNA HVAC Duct Construction Standards for sheet steel width and gage and steel rod diameters.

E. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger.

F. Sleeves:

1. Sleeves for round ductwork: Form with galvanized steel.

2. Sleeves for rectangular ductwork: Form with wood or galvanized steel.

3. Size sleeves large enough to allow for movement due to expansion and contraction.

G. For galvanized steel ducts provide hot-dipped galvanized steel support materials. For stainless steel provide stainless steel support materials. For aluminum provide aluminum support materials, except where materials are electrolytically separated from ductwork.

2.05 RECTANGULAR DUCT FABRICATION

A. Except as otherwise indicated, fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications and joint types and intervals.

B. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

C. Provide materials that are free from visual imperfections such as pitting, seam

marks, roller marks, stains and discoloration.

D. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

1. Supply Ducts: 3 inches water gage.
2. Return Ducts: 2 inches water gage, negative pressure.
3. Exhaust Ducts: 2 inches water gage, negative pressure.

E. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA HVAC Duct Construction Standards, unless they are lined or are externally insulated.

2.06 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections and other duct construction in accordance with SMACNA HVAC Duct Construction Standard.

B. (Not used)

2.07 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve necessary thickness is prohibited.

B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

1. Butt transverse joints without gaps and coat joint with adhesive.

2. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

C. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

D. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

E. Secure transversely oriented liner edges facing the air stream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

1. Fan discharge.
2. Intervals of lined duct preceding unlined duct.

2.08 ROUND DUCT FABRICATION

A. Fabricate round supply ducts with spiral lock seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater that 72 inches with longitudinal butt-welded seams. Comply with SMACNA HVAC Duct Construction Standards for galvanized steel gages.

B. Double-Wall (Insulated) Ducts: Fabricate double-wall insulated ducts with an outer shell, insulation and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions

1. Thermal Conductivity: 0.27 Btu/sq.ft./F/inch thickness at 75^{o}F mean temperature.

2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation and in gages specified above for single-wall duct.

C. Insulation: Unless otherwise indicated, provide 1-inch thick fiberglass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the inner liner diameter.

D. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gages listed below.

2.09 ROUND DUCT FITTINGS

A. 90-Degree Tees and Lateral and Conical Tees: Fabricate to conform to SMACNA HVAC Duct Construction Standards with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting form the body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, pleated or mitered construction with bend radius of 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.

2. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA HVAC Duct Construction Standards Table 3-1.

3. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:
    a. 3 to 26 inches: 24 gage.
    b. 27 to 36 inches: 22 gage.
    c. 37 to 50 inches: 20 gage.
    d. 52 to 60 inches: 18 gage.

4. Round Mitered Elbows: Solid welded and with metal thickness listed for pressure classes from 2 inches to 10 inches:
    a. 3 to 14 inches: 24 gage.
    b. 15 to 66 inches: 22 gage.
    c. 27 to 50 inches: 20 gage.
    d. 52 to 60 inches: 18 gage.
    e. 62 to 84 inches: 16 gage.

5. Round Elbows - 8 inches and smaller: Die-formed elbows for 45^{o} and 90^{o} elbows and pleated elbows for 30,45,60 and 90 degrees only. Fabricate non-standard bend angle configurations or 1/2-inch diameter (e.g. 3-1/2 and 4-1/2 inch) elbows with gored construction.

6. Round Elbows- 9 through 14 inches: Gored or pleated elbows for 30, 45, 60 and 90 degrees, except where space restrictions require a mitered elbow. Fabricate non-standard bend angle configurations or 1/2-inch diameter (e.g. 9-1/2 and 10-1/2 inch) elbows with gored construction.

7. Round Elbows- Larger than 14 inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

8. Die-Formed Elbows for Sizes Through 8 inches and All Pressures: 20 gage with 2-piece welded construction.

9. Round Gored Elbows Gages: Same as non-elbow fittings specified above.

10. Flat Oval Elbows Gages: Same as longitudinal seam flat oval duct.

11. Pleated Elbows Sizes Through 14 inches and Pressures Through 10 inches:26 gage.

D. Double-Wall (Insulated) Fittings: Fabricate double-wall insulated fittings with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.

1. Thermal Conductivity: 0.27 Btu/sq.ft./F/inch thickness at 75°F mean temperature.

2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation and in gages as specified above for uninsulated fittings.

E. Insulation: Unless otherwise indicated, provide 2-inch thick fiberglass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.

F. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gages listed below. For flat oval ducts, the diameter indicated in the table below is the basic round diameter.

1. 3 to 34 inches: 24 gage.

2. 35 to 58 inches: 22 gage.

3. 60 to 88 inches: 20 gage.

4. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation form dislocation by mechanical means.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Construct and install each duct system for the specific duct pressure classification
indicated. Provide openings in ductwork where required to accommodate thermometers and controllers.

B. Install ducts with fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections
kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building line; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment.

1. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partition, except as specifically shown.

2. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

3. Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Provide clearance of 1-inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

H. Install insulated ducts with 1-inch clearance outside of insulation.

I. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

3.02 SEAM AND JOINT SEALANT

A. Seal duct seams and joints as follows:

1. Pressure Classifications Greater than 3 Inches Water Gage: All transverse joints, longitudinal seams and duct penetrations.

2. Pressure Classification 2- and 3-Inches Water Gage: All transverse joints and longitudinal seams.

3. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only.

4. Seal externally insulated ducts prior to insulation installation.

3.03 HANGING AND SUPPORTING

A. Install rigid, round, rectangular and flat oval duct with support systems indicated in SMACNA HVAC Duct Construction Standards.

1. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

2. Support vertical ducts at a maximum interval of 16 feet and at each floor.

B. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

C. Install concrete insert prior to placing concrete.

D. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.04 CONNECTIONS

A. Connect equipment with flexible connectors in accordance with Section 15910 Ductwork Accessories.

B. All duct connections shall comply with SMACNA HVAC Duct Construction Standards.

3.05 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Adjustments shall be in accordance with Section 15990 Testing, adjusting and balancing air systems.

B. Vacuum ducts systems prior to final acceptance to remove dust and debris.

END OF SECTION 15891

SECTION 15910
DUCTWORK ACCESSORIES

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 all ductwork accessories. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer'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 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.

C. Types of ductwork accessories required for project include the following:

1. Low Pressure manual dampers.
2. Fire and smoke dampers.
3. Turning vanes.
4. Duct hardware.
5. Duct access doors.
6. Flexible connections.
7. Counter Balanced relief dampers.

D. Related Work Specified Elsewhere:

1. Section 15050, Basic Mechanical Materials and Methods.
2. Section 15891, Ductwork.
3. Section 15990, Testing, Adjusting and balancing of HVAC Systems.

1.02 SUBMITTALS

A. 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. Product Data. Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction, and installation instructions.
    a. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
    b. Data sheet for each type of air outlet and inlet, and accessory furnished, indicating construction, finish, and mounting details.
    c. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

2. Manufacturer's assembly-type drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

B. Maintenance Data. Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual, in accordance with requirements of General Conditions of the Contract Documents.

1.03 QUALITY ASSURANCE

A. Reference standards. Comply with all Federal state laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. SMACNA Compliance. Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

2. Industry Standards. Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

3. UL Compliance. Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".

4. NFPA Compliance. Comply with applicable provisions of NFPA 90A "Air conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

5. ADC Compliance. Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

6. ADC Seal. Provide air outlets and inlets bearing ADC Certified Rating Seal.

7. AMCA Compliance. Test and rate louvers in accordance with AMCA 500 Test Method for louvers, Dampers and Shutters."

8. AMCA Seal. Provide louvers bearing AMCA Certified Rating Seal.

1.04 QUALITY STANDARDS

A. All ductwork accessories 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.

C. Manufacturer's offering products that comply with these specifications include:

1. Dampers:
    a. Air Balance, Inc.
    b. Airguide Corp. American Warming & Ventilating, Inc.
    c. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
    d. Louver & Dampers, Inc.
    e. Penn Ventilator Co.
    f. Ruskin Mfg. Co.
    g. Or equal.

2. Fire Dampers:
    a. Air Balance, Inc.
    b. American Warming & Ventilating, Inc.
    c. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.

d. Louvers and Dampers, Inc.
e. Penn Ventilator Co.
f. Phillips-Aire.
g. Ruskin Mfg. Co.
h. Or equal.

3. Turning Vanes:
   a. Aero Dyne Co.
   b. Airson Corp.
   c. Barber-Colman Co.
   d. Duro Dyne Corp.
   e. Environmental Elements Corp.; Subs. Koppers Co., Inc.
   f. Souther, Inc.
   g. Hart & Cooley Mfg. Co.
   h. Or equal.

4. Duct Hardware:
   a. Ventfabrics, Inc.
   b. Young Regulator Co.
   c. Or equal.

5. Duct Access Doors:
   a. Air Balance Inc.
   b. Duro Dyne Corp.
   c. Register & Grille Mfg. Co., Inc.
   d. Ruskin Mfg. Co.
   e. Ventfabrics, Inc.
   f. Zurn Industries, Inc.; Air Systems Div.
   g. Or equal.

6. Flexible Connectors:
   a. American/Elgen Co.; Energy Div.
   b. Duro Dyne Corp.
   c. Flexaust (The) Co.
   d. Ventfabrics, Inc.
   e. Or equal.

7. Counterbalanced Relief Dampers:
   a. Air Balance, Inc.
   b. Airguide Corp.
   c. American Warming & Ventilating, Inc.
   d. Arrow Louver and Damper; Div. of Arrow United Industries.
   e. Louvers & Dampers, Inc.
   f. Penn Ventilator Co.
   g. Ruskin Mfg. Co.
   h. Or equal.

1.05 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 DAMPERS

A. Low Pressure Manual Dampers. Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards." Volume dampers shall be provided with recommended size quadrants per SMACNA standard. Where ductwork is externally insulated provide quadrants on a stand off so that they are accessible.

2.02 FIRE DAMPERS

A. Fire Dampers. Provide fire dampers, of types and sizes indicated. Construct casings of 10-ga galvanized steel with bonded red acrylic enamel finish. Provide fusible link rated at 160 to 165 degrees F unless otherwise indicated. Provide damper with positive lock in closed position, and with the following additional features:

1. Damper Blade Assembly. Curtain type.
2. Blade Material. Steel, match casing.

2.03 TURNING VANES

A. Fabricated Turning Vanes: Provide fabricated turning vanes and vane runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards".

B. Manufactured Turning Vanes: Provide turning vanes constructed of 1-½-inch wide curved blades set at ¾-inch o.c., supported with bars perpendicular to blades set at 2-inches o.c., and set into side strips suitable for mounting in ductwork.

C. Acoustic Turning Vanes: Provide acoustic turning vanes constructed of airfoil shaped aluminum extrusions with perforated faces and fiberglass fill.

2.04 DUCT HARDWARE

A. General. Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

B. Quadrant Locks. Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

C. Test holes. Provide in ductwork at fan inlet and outlet and elsewhere as required,
duct test holes, consisting of slot and cover for instrument tests.

2.05 DUCT ACCESS DOORS

A. General. Provide access doors where fire dampers or motorized dampers are installed in ductwork.

B. Construction. Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.

2.06 FLEXIBLE CONNECTIONS

A. General. Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

2.07 COUNTERBALANCED RELIEF DAMPERS

A. Provide dampers with parallel blades, counterbalanced and factory set to relieve at indicated static pressure. Construct blades of 16ga. aluminum, provide ½-inch diameter ball bearings, ½-inch diameter steel axles spaced on 9-inch centers. Construct frame of 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under; 4" x 11/4" x 16ga. channel for face ares over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touchup.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which ductwork accessories will be installed.
B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install turning vanes in square or rectangular 45- and 90-degree elbows in supply and
exhaust air systems, and elsewhere as indicated.

C. Install access doors with operable latches.

D. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

E. Locate diffusers, registers, and grilles, as indicated on Mechanical Drawings.

3.03 SPARE PARTS

A. Furnish to Engineer, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

3.04 FIELD QUALITY CONTROL

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.05 ADJUSTING AND CLEANING

A. Adjusting. Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action. Final positioning of

manual dampers is specified in Division 15, Section 15990, Testing, Adjusting, and Balancing.

B. Cleaning. Clean factory-finished surfaces. Repair any marred or scratched surfaces
with manufacturer's touch-up paint.

END OF SECTION 15910

SECTION 15950
HVAC CONTROLS

PART 1 - GENERAL

1.01 SCOPE

A. Extent of electric control systems work required by this Section is indicated on drawings and schedules, and by requirements of this Section. Control sequences are specified in this Section.

B. Refer to other Division 15 Sections for installation of manual volume dampers in
mechanical systems.

C. All work shall be in compliance with the National Electrical Code.

D. Refer to Division-16 Sections for the following work:

1. Power supply wiring for power source to control panels, starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

E. Furnish control and interlock wiring under this section between field installed controls, indicating devices, motorized damper operators and unit control panels in compliance with the requirements of Division 16.

F. Control panel enclosures, starters, and disconnect switches shall be furnished under this section in accordance with the requirements of Division 16.

1.02 SUBMITTALS

A. 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. Product Data. Manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions.

2. Schematic flow diagram of system showing fans, dampers, and control devices.

3. Label each control device with setting or adjustable range of control.

4. Control interlock wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

5. Details of faces of control panels, including controls, instruments, and labeling.

6. Written description of sequence of operation.

7. Wiring diagrams.

8. Operation and maintenance manuals.

1.03 QUALITY ASSURANCE.

A. Manufacturer's Qualifications. Only firms regularly engaged in the manufacture of electric control equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years shall be eligible to provide and install the equipment specified herein.

B. Codes and Standards.

1. Electrical Standards. Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.

2. NEMA Compliance. Comply with NEMA standards pertaining to components and devices for electric control systems.

3. NFPA Compliance. Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.04 QUALITY STANDARDS

A. Manufacturer. Subject to compliance with requirements, provide electric control systems of one of the following.

1. Honeywell, Inc.

2. Johnson Controls, Inc.

3. Siemens

4. Or equal.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to protect equipment from dirt and moisture. Store equipment and materials inside and in original shipping packaging.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT.

A. General. Provide electric control products in sizes and capacities indicated, consisting of dampers, thermostats, sensors, controllers, and other components as required for a complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide electric control systems with the following functional and construction features as indicated.

B. Dampers. Provide automatic control low leakage dampers as indicated, with damper frames not less than formed 13-ga galvanized steel. Provide mounting holes for duct or louver mounting as required. Provide damper blades not less than formed 16-ga galvanized steel, with maximum blade width of 8". Equip dampers with motors, with proper rating for each application. Damper section widths shall not exceed 48 inches.

1. Secure blades to ½" diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc plated steel and brass. Submit leakage and flow characteristics, plus size schedule for controlled dampers.

2. For standard applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with optional closed-cell neoprene edging.

3. For outside air dampers applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm/sq. ft. of damper area, at

differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.

C. Damper Motors. Size each electric damper motor to operate dampers or valves with sufficient reserve power to provide 2-position action as specified. Damper motors shall be suitable for 120-volt, single phase power and each motor shall be arranged to fail to its last position.

D. Room Thermostats. Provide room thermostats with locking covers, and with concealed or readily accessible adjustment devices and dead band, as indicated.

1. Provide thermostats with spiral bimetallic thermometers.

2. Thermostats. Provide 24 VAC thermostats of the bimetal actuated open contact, or bellows actuated enclosed snap-switch type, or equivalent solid-state type. Thermostat shall be UL-listed at electrical rating comparable with application. Provide bimetal thermostats which employ heat anticipation.

3. Thermostat for split system air-conditioning unit shall be by the unit manufacturer.

E. Electric Contactors. Provide contactors for operating or limit control of electric heating loads which are UL-listed for 100,000 cycles of resistive loads. Equip with replaceable molded coils and replaceable silver cadmium oxide contacts. Coat core laminations with heat-resistant inorganic film to reduce core losses. Provide line and load terminals on contactors with higher-than-35-amp rating, or provide one-piece formed-and-welded pressure type. Provide screw-type contactors for 35-amp-or-lower rating. Equip field-mounted contactors with suitable steel enclosures; and provide open-type mounting for those installed in factory-fabricated panels.

F. Fan Switches: Provide fan switches where indicated on the Drawings. Switches shall be factory sealed, shall be rated 600 VAC heavy duty and shall have indicating lights. Selector switches shall be two or three position as indicated on the Drawings:

1. START/STOP

2. HAND/OFF/AUTO

G. Control Wiring: All control, interlock and starting circuit wiring, except where otherwise specified or noted on the plans, is to be furnished under this Section.

1. Line voltage wiring shall not be smaller than #14, 600 volt wire. All wire shall be run in conduit with outlet boxes and fittings in compliance with the requirements of Division 16, Electrical.

2. 24 volt wiring shall be not less than #18 gauge, with 600 volt insulation. Wiring run in partitions or above ceilings shall be run in plenum rated cable.

3. Control voltage shall not exceed 120 volts. Provide transformers and relays to comply with this requirement.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which electric control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF ELECTRIC CONTROL SYSTEMS

A. General. Install systems and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division-16 Sections of these specifications. Mount controllers at convenient locations and heights.

B. Control Wiring. The term "control wiring" is defined to include provision of wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices.

C. Wiring System. Install complete control wiring system for electric control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

D. Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system.

3.03 ADJUSTING AND CLEANING.

A. Start-Up. Start-up, test, and adjust electric control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Final Adjustment. After completion of installation, adjust thermostats, damper operators, motors and similar equipment provided as work of this Section. Final adjustment shall be performed by specially trained personnel in direct employ of the manufacturer of primary temperature control system.

3.04 CLOSEOUT PROCEDURES

A. City's Instructions. Provide services of manufacturer's technical representative for four hours to instruct City's personnel in operation and maintenance of electric control systems. Schedule instruction with Engineer, provide at least 7 days of notice to Contractor and Engineer for training date.

B. (Not used)

3.05 SEQUENCE OF OPERATION

A. Maintenance Room Heating and Ventilation (Exhaust Fans EF-2/Wall Louver WL-1, Electric Unit Heaters EUH-1 and EUH-2)

1. When the exhaust fan’s HAND/OFF/AUTO switch is OFF, the exhaust fan shall be off and the intake air wall louver interlocked with that fan shall be closed.

2. When the switch is in HAND mode, the exhaust fan shall run and the intake air wall louver interlocked with that fan shall be open.

3. When the fan is in AUTO mode and the temperature sensed by the space thermostat rises above its set point (85 deg F – adjustable), the exhaust fan shall run and the intake air wall louver interlocked with that fan shall open.

4. The set points of space thermostats interlocked with exhaust fans EF-2 shall be staggered by 5 deg F (adjustable). And their set points to be alternated manually on a periodic basis to achieve equal wear of the exhaust fan.

5. The electric unit heaters controlled by their own integral thermostats (set at 55 deg F – adjustable) will provide heating in the space

B. Office Area Air Conditioning (Split System Heat Pump AC-1/HP-1)

1. Unit supply fan shall run continuously when the space is occupied, and the compressor shall cycle to maintain the space temperature setpoint.

2. Unit supply fan and compressor shall cycle to maintain the temperature setpoint during the unoccupied mode.

3. The space shall be provided with a programmable thermostat with night and weekend setback capability for both heating and cooling modes.

C. Electric Room Air Conditioning (Split System Heat Pump Unit AC-2/HP-2 and AC-3/HP-3)

1. When the unit's ON/OFF switch is in OFF position, the unit shall be off.

2. When the switch is in ON position, the AC unit shall run in alternating lead/lag mode to maintain the space cooling temperature set point of 85^{o} F (adjustable).

3. Both AC units shall run simultaneously if needed to meet the space cooling load demands.

4. When the space temperature goes above the space high temperature set point limit of 88^{o} F (adjustable), a high temperature alarm shall be activated for remote reporting. See P&ID drawings.

D. Toilet Exhaust (Exhaust Fan EF-1)

1. The toilet exhaust fan shall be interlocked with the light switch. When the light switch is ON, the exhaust fan shall run. When the light switch is OFF, the exhaust fan shall be off.

E. Microwave Exhaust (Exhaust Fan EF-3)

1. The exhaust fan shall be controlled by wall mounted ON/OFF switch with timer.

END OF SECTION 15950

SECTION 15990
TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section specifies the requirements and procedures for HVAC systems testing, adjusting and balancing. Requirements include measurement and establishment of the fluid quantities of the HVAC systems as required to meet design specifications, and recording and reporting the results.

B. The Contractor shall procure the services of an independent air balance and testing agency, who is a current member in good standing of the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project and having at least one technician certified by AABC or NEBB as a Test and Balance Engineer.

C. Test and balance all HVAC systems including the following:

1. Supply air systems, all pressure ranges; including variable volume and double duct systems.

2. Return air systems.

3. Exhaust air systems.

4. Verify temperature control system operation.

D. Test systems for proper sound and vibration levels.

E. Related work specified elsewhere:

1. Section 15950, HVAC Controls.

F. Definitions:

1. Systems testing, adjusting and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
    a. The balance of air distribution.
    b. Adjustment of total system to provide design quantities.
    c. Electrical measurement.

d. Verification of performance of all equipment and automatic controls.
e. Sound and vibration measurement.

2. Test: To determine quantitative performance of equipment.

3. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment.

4. Balance: To proportion flows within the distribution system (submains, branches and terminals) according to specified design quantities.

5. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

6. Report forms: Test data sheets arranged for collecting data in logical order for submission and review. This data should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.

7. Terminal: The point where the controlled fluid enters or leaves the distribution system. There are supply outlets on air terminals and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers and hoods.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Condition of the Contract Documents. In addition, the following specific information shall be provided:

1. Submit testing agency's name for approval; include resume of at least ten similar projects including testing dates, project name, system description and contractor.

2. Name of certified Test and Balance Engineer assigned to supervise the procedure and the technicians proposed to perform the procedures.

3. Submit a synopsis of the testing, adjusting and balancing procedures and agenda proposed for the project.

4. Maintenance and operating data that includes how to test, adjust and balance the building systems.

5. Copies of test reports intended for use.

B. Preconstruction Plan Check and Construction Review.

1. The Contractor is to insure that the testing agency is provided with up-to-date Contract Documents and all Contractor submittals related to the Work required by this Section.

2. Provide a preconstruction plan check in accordance with the procedure specified in the referenced standards. Submit a written report of the plan check to the Engineer for review prior to commencement of HVAC Systems installation.

3. Provide periodic construction review during the progress of related HVAC systems installation in accordance with the procedures specified in the referenced National Standards.

C. Pre-TAB Checklist

1. Prior to the Testing, Adjusting and Balancing (TAB) Work for any HVAC system, submit a completed AABC "Systems Ready to Balance Checklist" to the Engineer for records. The Contractor is to insure that all work is complete and ready for TAB.

D. Certified Reports: Submit testing, adjusting and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted and balanced in accordance with referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:

1. Draft Reports: Upon completion of testing, adjusting and balancing procedures, prepare draft reports on the approved forms. Organize and format draft reports in the same manner specified for the final reports (drafts may be handwritten). Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

2. Final Reports: Upon verification and approval of draft reports, prepare final reports, type written and organized and formatted as specified in paragraph 2.01. Submit 2 complete sets of final reports.

3. Calibration reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.03 QUALITY ASSURANCE

A. 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. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers- Fundamental Handbook, Ch. 13; System and Application Handbook, Ch. 57.

2. SMACNA, Sheet Metal and Air Conditioning Contractors' National Association- Testing, Balancing and Adjusting of Environmental Systems; HVAC Systems.

3. AABC, Associated Air Balance Council- National Standards for Total System Balance.

4. NEBB, National Environmental Balancing Bureau- Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

B. The testing agency shall be the single source of responsibility to test, adjust and balance the HVAC systems and produce the design objectives.

1.04 SEQUENCING AND SCHEDULING

A. Test, adjust and balance air conditioning systems before refrigerant systems.

B. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5^{o} F wet bulb temperature of maximum summer design condition, and within 10^{o}F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide all necessary TAB devices, instrumentation, test equipment, electricity, HVAC system accessories and specialties required to accomplish the Work specified in this Section. The Contractor is responsible for the proper placement of such items in the HVAC system.

B. Certified TAB Report.

1. Report forms shall be standard forms as prepared by the referenced standard for each respective item and system to be tested, adjusted and balanced. Bind report forms, complete with schematic systems diagrams

and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the following divisions:

a. General Information and Summary
b. Air Systems
c. Temperature Control Systems
d. Sound and Vibration Systems

2. Certification Form shall include most current date on Contract Documents.

3. The certified test report shall include, but not be limited to, the following Forms and Test Reports:
   a. Instrument list form.
   b. Air moving equipment test report shall include the additional information:
      1) Design and operating motor brake-horsepower.
      2) Manufacturer's fan curve with design and operating points plotted.
      3) Operating voltage and amperage.
      4) Motor starter heater element sizes.
   c. Static pressure profile form.
   d. Air terminal test forms.
   e. Rectangular duct traverse report.
   f. Round duct traverse report.

PART 3 – EXECUTION

3.01 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system perform the following steps:

1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.

2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return and exhaust) and temperature control diagrams.
3. Compare design to installed equipment and field installations.

4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.

5. Check filter for cleanliness.

6. Check dampers (both volume and fire) for correct and locked position and temperature control for completeness of installation before starting fans.

7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.

8. Determine best locations in main and branch ductwork for most accurate duct traverses. Place outlet dampers in the full open position.

9. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.02 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage. Take all measurements in the system where best suited to the task.

1. Instruments shall meet the specifications of the referenced standards.

2. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

3. Apply instrument as recommended by the manufacturer.

B. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

C. Take all readings with the eye at the level of the indicated value to prevent parallax.

D. Use pulsation dampeners where necessary to eliminate error involved in estimating averages of rapidly fluctuating readings.

3.03 TESTING, ADJUSTING AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.

1. Cut insulation, ductwork and piping for installation of test probes to the minimum extent possible to allow adequate performance of procedures.

2. Patch insulation, ductwork and housings using materials identical to those removed.

3. Seal ducts and piping, and test for and repair leaks. Seal insulation to re-establish integrity of the vapor barrier.

4. Mark equipment settings, including damper control position, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

5. Retest, adjust and balance systems subsequent to significant system modifications and resubmit test results.

B. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards.

C. Adjust all HVAC systems to deliver the specified air quantities within the following tolerances:

1. Equipment (fans, heat transfer equipment, and air terminal units). ±10%.

2. Air outlets. ±10%.

3.04 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory performances when system cannot be successfully balanced.

3.05 DEMONSTRATION

A. Submit the final TAB report for review along with Contractor's completed checklist of recommendations for correcting unsatisfactory areas identified by testing agency.

B. Pre-test all systems prior to inspection and acceptance tests required by referenced standards. Provide detailed documentation of the referenced standard inspection tests by the Contractor and include test procedures, participants, dates and times, instruments used, test data and a summation of test results. Submit test reports prior to system commissioning tests conducted by the City.

C. System Commissioning Tests.

1. Tests shall demonstrate that capacities and general performance of air

systems comply with Contract requirements.

2. At the time of system commissioning, recheck, in the presence of the Engineer, random selections of data (air quantities and air motion) recorded in the certified TAB test report.

3. Selections for checks in general will not exceed 25 percent of the total number tabulated in the report.

D. Train the City's maintenance personnel on troubleshooting procedures and testing, adjusting and balancing procedures. Review with the City personnel the information contained in the Operating and Maintenance Manual.

E. Schedule training with City with at least 7 days prior notice.

3.06 SERVICES

A. Retests. If random tests elicit a measured flow deviation exceeding the specified tolerances, the TAB report will automatically be rejected. In the event the report is rejected, readjust and test all systems, record new data, submit new certified Reports and perform new rechecks at no additional cost to the City; including time required by the Engineer.

B. Reinspection. TAB Agency shall make 2 return inspection trips to the project, one during heating design conditions and one during air conditioning design conditions for the purpose of checking out the entire system or group of systems.

C. Readjustments. Balancing agency shall make additional adjustments required during the reinspection.

END OF SECTION 15990

SECTION 16000
ELECTRICAL POWER AND SYSTEMS
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SECTION 16000
ELECTRICAL POWER AND SYSTEMS

PART 1. GENERAL

1.1 SCOPE

A. The electrical work commences with the point of electrical service where shown on the Drawings and includes furnishing all material and labor for a complete electrical installation.

B. The requirements of Division 1 apply to all work hereunder. The General and Special Conditions are a part of this Division of the Specifications and all provisions contained therein which affect this work are as binding as though incorporated herein.

1.2 DEFINTIONS

A. Provide: Furnish, install, and connect.

B. Product Data: Catalog cuts and descriptive literature.

C. Shop Drawings: Factory prepared specific to the installation.

D. Low Voltage: 0-600 volts.

E. High Voltage: Above 600 Volts.

F. Indicated: Shown on the Drawings.

G. Noted: Indicated or specified elsewhere.

1.3 MATERIAL NOT FURNISHED

A. Unless otherwise noted, the following are furnished and installed under other Divisions:

1. Motors

2. Electric heating and air conditioning equipment

3. Electrical heat tracing

4. Pilot and control devices for the above equipment

B. Power wiring and equipment connections for the above items are included in this Division. Also included in this Division is control wiring to the extent shown on the Electrical Drawings; other control wiring is furnished under the applicable Mechanical Division.

1.4 LOCAL CONDITIONS

A. Power will be supplied by the utility company substation. Verify and comply with all power company requirements for connections to new substation bus. Make necessary arrangements with the power company for temporary service requirements. Have the power company review submittals on equipment containing utility metering sections.

B. Verify and comply with all requirements of the local telephone company concerning the complete telephone system.

1.5 QUALITY ASSURANCE

A. Provide the complete electrical installation in accordance with the 2011 National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), and in accordance with applicable local codes. Obtain all necessary permits and have all work inspected by appropriate authorities.

B. All products shall be designed, manufactured, and tested in accordance with industry standards. Where applicable, products shall be labeled or listed by third party certification agencies.

C. Industry Standards: Standards organizations and their abbreviations, as used herein, are as follows. Applicable date for industry standards is that in effect on the date of advertisement of the Project.

1. American National Standards Institute (ANSI)

2. American Society for Testing and Materials (ASTM)

3. Federal Specifications (FS)

4. Institute of Electrical and Electronics Engineers (IEEE)

5. Insulated Cable Engineers Association (ICEA)

6. National Electrical Manufacturers Association (NEMA)

7. National Fire Protection Association (NFPA)

8. Underwriters Laboratories, Inc. (UL)

9. Southern Building Code (SBC)

1.6 SUBMITTALS

A. Make all submittals in accordance with the requirements of Section 01340.

Approval drawings consist of shop drawings, product data and other information as noted in the individual equipment sections. Except as noted, submittal information is for approval and equipment may not be installed until submittals have been returned with stamped approval.

B. Information required "for reference" such as product samples, similar unit test reports and time current curves is for the purpose of determining the suitability of a product, selecting breaker settings, etc. This information is to be submitted at the same time as approval data; however, this information will not be returned, and stamped approval is not required prior to installing the equipment.

C. Except as noted, installation instructions are not required to be submitted. However, it is the Contractor's responsibility to obtain installation information from the manufacturer for all equipment prior to installing the equipment.

D. Submit O&M data per Section 01730.

1.7 RECORD DRAWINGS

A. Furnish record drawings in accordance with the requirements of Section 01720. Record drawings consist of submittal data as listed above, operation and maintenance data, and as-built drawings. Record drawings are to reflect the final installation, including any changes during approval, manufacturing tests, and installation.

B. In addition to other required sets, furnish one set of operation and maintenance data for all apparatus requiring service in accordance with Section 01730.

C. Coordination Study: Furnish 3 copies incorporating any changes and corrections from submittal phase.

D. As-Built Drawings: Furnish one set of prints maintained at the job site at all times with all changes during construction marked thereon. Include on the as-built drawings sufficient dimensions to permit location of underground conduits.

E. Submit the results of any tests required in the individual equipment sections.

1.8 COORDINATION STUDY

A. The contractor shall furnish short-circuit, protective device coordination and arc flash studies (for WWTP and IPS) which shall be prepared by the project electrical design engineers or approved equal consulting engineering firm having a minimum of 10 years relevant experience in preparation of plant power studies.

B. Short circuit study of complete electrical distribution system showing maximum fault level at buses.

C. Submit system protection coordination study and short circuit study before

submittal of equipment shop drawings.

D. Obtain a harmonic analysis study from the variable frequency drive manufacturer in accordance with Section 16489.

E. Submittal Requirements: Submit the coordination study prior to, or concurrent with, distribution equipment within the study scope. This is to allow suggested improvements (relay ranges, CT ratios, etc.) that may arise in performing the study to be incorporated prior to equipment fabrication. Review procedures are as specified in Article 1.6 above.

1.9 DELIVERY, STORAGE AND HANDLING

A. Ship products to the job site in their original packaging. Receive and store products in a suitable manner to prevent damage or deterioration. Receive and store products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times. Provide heat (incandescent lamps or temporary power for space heaters) for distribution equipment until equipment is energized.

B. Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

PART 2. PRODUCTS

2.1 MATERIALS

Provide only new products of the manufacturer’s latest design.

2.2 SUBSTITUTIONS

A. Where the words “equal to” follow or precede the listed acceptable manufacturers, equal products of other manufacturers are acceptable and request for substitution may be made during submittal stage.

B. Where the words “or equal” follow the listed acceptable manufacturers, products of other manufacturers must be submitted and approved prior to the Bid, in accordance with the Instructions to Bidders of the Contract Documents.

PART 3. EXECUTION

3.1 INSTALLATION

A. The complete installation is to be accomplished by skilled electrical tradesmen, with certified or suitably qualified individuals performing all special systems installation and testing. All workmanship shall be of the highest quality, sub-standard work will be rejected.

B. Schedule the work and cooperate with all trades to avoid delays, interferences, and unnecessary work. If any conflicts occur necessitating departures from the Drawings and Specifications, details of departures and reason therefore shall be submitted immediately for the Engineer's consideration.

C. Prior to final inspection, clean all dirt, mud and construction debris from all boxes, cabinets, manholes and equipment enclosures.

3.2 CERTIFICATION AND TESTS

A. Prior to request for final review, test all systems and repair or replace all defective work. Submit, with request for final review, written certification that all electrical systems are complete and operational.

B. At the time of final review of electrical work, demonstrate the operation of electrical systems. Furnish labor, apparatus and equipment for systems' demonstration.

C. After final review and acceptance, turn over to the Owner all keys for electrical equipment locks. Present to the Owner of the Owner's designated representative, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS
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SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1. GENERAL

1.1 SCOPE

This Section includes basic materials and methods common to all Sections of Division 16.

1.2 SUBMITTIALS

Submit product data.

PART 2. PRODUCTS

2.1 BOXES

A. Sheet Metal Boxes: NEMA OS-1.

B. Cast Boxes: Galvanized with gasketed cover and threaded hubs.

C. Floor Boxes: Cast iron, adjustable.

2.2 DISCONNECT SWITCHES

A. Disconnect Switches: UL-98 and NEMA KS-1; 600-volt; heavy duty; quick make, quick break type; horsepower and I^2t rated. Provide lever type operating handle directly connected to the switch mechanism; rocker types are not acceptable. Include padlocking provisions and nameplate clearly indicating “ON” and “OFF” positions. Equip all switches with a ground lug and, where neutral conductors are scheduled, provide insulated neutral lugs.

B. Fusible Switches: Equip with rejection clips for types noted.

C. Enclosure: As indicated. NEMA 4/4X enclosures are stainless steel.

D. Acceptable Manufacturer: Equal to Eaton, ABB / GE, Schneider Electric or Siemens.

2.3 INDIVIDUAL MOTOR STARTERS

A. Manual Starters: NEMA ICS-2; general purpose type; trip-free mechanism; with overload relays. Provide pushbutton operation for integral horsepower sizes, and toggle switch or lever for fractional sizes.

B. Magnetic Starters: NEMA ICS-2; NEMA size 1 minimum; magnetically held

contactor with field replaceable coil and contacts; bimetallic or melting alloy overload relay, manually reset. Starters shall be rated in accordance with NEMA size designations; fractional sizes and ratings per IEC recommendations are not acceptable.

C. Magnetic Starter Controls: All controls are 120 volts. Equip each starter with a control power transformer fused on the primary and secondary. Provide starter and overload relay auxiliary contacts for red run light, green stop light and amber overload light on the enclosure door. Provide one spare normally open starter auxiliary contact, and door mounted start-stop pushbuttons or hand-off- auto selector switch as indicated.

D. Combination Starters: Molded case circuit breaker rated 22,000 AIC.

E. Enclosure: As indicated. NEMA 4/4X enclosures are stainless steel.

F. Acceptable Manufacturers: Equal to Eaton, ABB / GE, Siemens or Schneider Electric.

2.4 CONTACTORS

A. Control Relays: NEMA A600; heavy duty, machine tool type convertible contacts; electrically held 120-volt coil. Equal to Allen-Bradley Bulletin 700 Type P.

B. General Purpose Contractors: NEMA ICS-2; electrically held; 2-wire control; 120-volt coil. Size and number of contacts as indicated.

C. Lighting Contactors: NEMA ICS-2; mechanically held; 3 wire control; 120-volt coil. Size and number of contacts as indicated.

D. Enclosure: NEMA ICS-6; Type 1 unless otherwise noted.

E. Acceptable Manufacturers: Equal to ABB / GE, Eaton, Schneider Electric, or ASCO.

2.5 CONTROL STATIONS

A. Pushbuttons, Selectors and Pilot Lights: 600-volt, heavy duty, factory sealed.

B. Enclosure: Stainless steel meeting NEMA 4X and NEC Class I, Division 2, Group C and D requirements.

C. Acceptable Manufacturers: Equal to Allen-Bradley Bulletin 800T.

D. Hazardous Areas: Where Division 1 classified areas are indicated, provide control stations equal to Crouse-Hinds EFS/EFD series.

2.6 FUSES

A. Fuses: Current limiting, non-renewable type, rated 200,000 AIC, with rejection feature; Class J for ratings 600 amp and below and Class L for ratings 601 amp and above.

B. Acceptable Manufacturers: Equal to Bossman, Chase-Shawmut, or Littelfuse.

2.7 PLYWOOD BACKBOARDS

A. Backboards: Grade BC plywood, ¾-inch thick. Paint with two cots of flat black paint.

2.8 SUPPORTING DEVICES

A. Support Channel: Stainless-steel

B. Hardware: Stainless-steel

2.9 ELECTRICAL IDENTIFICATION

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Wire and Cable Markers: Plastic, split sleeve or tubing type.

PART 3. EXECUTION

3.1 BOXES

A. Provide boxes as shown on the Drawings and as required for splices, taps, wire pulling and equipment connections. Support boxes independently of conduit. Provide knockout closures for unused openings.

B. Box locations shown on the Drawings are approximate unless dimensioned. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes and other furnishings. Locate outlet boxes to permit handicap access per ANSI A117.1. Where receptacles are indicated 18-incyhes above finished floor, dimension is to the bottom of the box. At the option of the Owner’s representative, any outlet may be relocated by up to 10 feet before it is permanently installed, without incurring additional cost. Install adjacent devices at the same elevation in a common box with on face plate. Install adjacent devices at different elevations in one vertical line.

C. Unless otherwise noted, use only cast outlet boxes. Sheet metal boxes may be used where concealed above ceilings or in dry walls, exposed in electrical closets, and for telephone wiring.

D. Field drill conduit holes in tap, junction and pull boxes so as to afford the

maximum bending radius for the conductors.

3.2 DISCONNECT SWITCHES

A. Provide switches with voltage, ampere, and number of poles as indicated on the Drawings.

B. Switches are non-fused type, unless Drawings note otherwise, or the switch is used as a disconnect for an item of equipment with a maximum fuse size designated on the nameplate. In such cases, provide fusible type with appropriate fuse. If fusible switches protect conductors with an ampacity less than the rating of the switch, provide a nameplate on the inside front cover of the switch designating the maximum allowable fusing.

C. Install switches so they are rigidly supported and readily accessible. Where mounted on stud walls, provide a plywood backboard secured to the studs with the switch secured to the backboard. Provide stainless steel mounting channel or phenolic spacers to give nominal ½-inch separation from concrete walls in wet or damp locations.

D. For disconnect switches serving motors with space heaters, provide lamecoid nameplate engraved “WARNING - Motor space heater energized with switch open”.

3.3 INDIVIDUAL MOTOR STARTERS

A. Select and install heater elements in motor starters to match installed motor characteristics. Do not use NEC motor full load ampere data for heater selection.

B. Provide a typed label inside each motor starter enclosure door identifying the motor served and listing the motor nameplate data. Provide an engraved nameplate on the exterior of the enclosure door identifying the motor served, the horsepower, voltage and phase rating.

C. Install starters so they are rigidly supported and readily accessible. Where mounted on stud walls, provide a plywood backboard secured to the studs with the starter secured to the backboard. Provide stainless steel mounting channel or phenolic spacers to give nominal ½-inch separation from concrete walls in wet or damp locations.

3.4 CONTACTORS

A. Install timer and lighting controls for contactors as indicated.

B. Install indicator lights in enclosure door as indicated

3.5 CONTROL STATIONS

A. Install control station so they are rigidly supported and located so as not to impair access to equipment for maintenance.

3.6 FUSES

A. Equip all fusible devices with fuses. Replace all brown fuses up to final acceptance of the Project. At the 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.

3.7 PLYWOOD BACKBOARDS

A. Provide plywood backboards for surface mounted electrical distribution equipment in areas such as mechanical rooms, electrical closets, and equipment rooms. Secure backboards to the building structure and paint with two coats of flat black paint.

3.8 SUPPORTING DEVICES

A. Fasten hangar rods, support stands, conduit clamps, etc. to building structure using expansion anchors or beam clamps.

B. Do not fasten supports to piping, ductwork, mechanical equipment or conduit. Do not use powder actuated fastening devices. Do not drill structural steel members.

3.9 ELECTRICAL IDENTIFICATION

A. Provide nameplates for all switchboards, panelboards, transformers, disconnect switches, individual motor starters and other items of electrical distribution equipment. Engrave with the equipment identification as indicated; and the voltage, current and interrupting rating. Attach nameplates with screws or rivets; adhesives are not acceptable. Exception: Two-part epoxy glue may be used for NEMA 4/4X enclosures.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING
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SECTION 16060
GROUNDING AND BONDING

PART 1. GENERAL

1.1 SCOPE

A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

B. Documents and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

C. Related Sections include but are not limited to:
   1. Section 02222 – Excavation, Trenching and Backfill.
   2. Section 16120 – Wire and Cable (600V).

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. American Society for Testing and Materials (ASTM).
      a. ASTM B3 – Specification for Soft or Annealed Copper Wire.
      b. ASTM B8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      c. ASTM B33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
   2. Underwriters Laboratories Inc. (UL).
      a. UL 467 – Standard Grounding and Bonding Equipment.
      b. UL 486A and UL 486B – Standard Wire Connectors.
   3. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.

1.3 SUBMITTALS

A. General: Submit each item in this Article per the requirements of Section 01300 - Submittals.

B. Product Data for grounding rods, connectors and connection materials, and grounding fittings.

C. Qualification data for firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects

with project names and addresses, names and addresses of architects and owners, and other information specified.

D. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the international Electrical Testing Association (NETA).
   1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3 of this Section.

B. Comply with NFPA 70.

C. Comply with UL 467.

D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

E. See Also Spec 16010 – General Electrical Requirements, Part 1 for listing of applicable reference standards.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Apache Grounding; Nashville Wire Products.
   2. Chance: A. B. Chance Co.
   3. Erico Products- Cadweld.
   4. Burndy Co.
   5. Fushi Int.- Copperweld
   6. Continental Industries – Thermoweld.
   7. Heary Brothers Lightning Protection Co.
   8. Ideal Industries, Inc.
   9. Kearney.
   10. Lightning Master Corp.
   11. O-Z/Gedney Co.
   12. Thomas & Betts, Electrical.

13. Or accepted equal.

2.2 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirement and the greater size, rating, and quantity indications shown shall be adhered.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Section 16120 - Wire and Cable (600V). Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductors: Insulated with green color insulation.

C. Grounding-Electrode Conductors: Stranded copper cable.

D. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.

E. Bare Copper Conductors: Conform to the following:
   1. Solid Conductors: ASTM B 3.
   2. Assembly of Stranded conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.

2.4 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire unless indicated otherwise, terminated with copper ferrules.

C. Bonding straps: Soft copper, 0.05-inch thick and 2-inches wide, except as indicated.

2.5 GROUNDING PRODUCTS

A. Pressure connectors: High-conductivity-plated units.

B. Bolted Clamps: Heavy-duty type.

C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combination of conductors and connected items.

2.6 GROUNDING ELECTRODES AND TEST WELLS

A. Grounding Rods: Copper-clad steel.
   1. Size: 3/4-inch by 120-inches. Length shall be adjusted to meet the required resistivity.

B. Test Wells: Grounding rod, as above, driven through drilled hole in bottom of handhole. Handhole minimum size 12-inch x 1-inch x12-inch with cover. See 3.02 below.

PART 3. EXECUTION

3.1 APPLICATION

A. Equipment grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.

1. Metallic Raceways: Raceways, conduits and cable trays, etc. shall be made electrically and mechanically continuous, and shall be bonded/ grounded to earth. Utilize jumpers, clamps, etc. as necessary to meet requirements for NEC. Install a grounding conductor in each metallic raceway, conduit and cable tray.
2. Nonmetallic Raceways: Install a grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, backboard, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and wiring Closets: Terminate grounding conductor on a 1/4-inch x 2-inch x 12-inch ground bus mounted on insulated standoffs.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC.

D. Grounding and Bonding for Piping and Metallic Parts:

1. Ground and bond piping to meet NEC and requirement of local Authority Having Jurisdiction, and as shown on the Drawings.
2. Ground and bond metallic structures, supports, fences, handrails, misc. metallic parts and similar items which are in proximity to electrical equipment, conduit and wiring and which are likely to become electrified upon fault or short of the electrical equipment, conduit or wiring.

E. Grounding and Bonding Metal Air Ducts: Ground and Bond metal air ducts to equipment grounding conductors of associated fans, blowers, heaters and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.2 INSTALLATION

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Grounding Electrode System: Each building or structure with electric service and with a metal underground water pipe, the metal frame of the building or structure, concrete encased electrodes, any ground ring encircling the building or structure and all made electrodes (ground rods, etc.) shall be bonded together to form the grounding electrode system. The main bonding jumper and the grounding electrode conductor shall be installed and sized per NEC except where larger sizes than required by NEC are indicated.

C. Electrical Room Grounding Bus: Space 2-inch from wall and support from wall 6-inches above finished floor, except as otherwise indicated.

D. Grounding Rods: A minimum of two (2) ground rods shall be installed where the ground rod serves as the grounding electrode per NEC. Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.
   1. Drive until tops are 2-inches below finished floor or final grade, except as otherwise indicated.
   2. Interconnect with grounding-electrode conductors. Except at test wells and as otherwise indicated, use exothermic welds. Make these connections without damaging copper coating or exposing steel.

E. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

F. Underground Grounding Conductors: Use bare, soft-drawn copper wire: Bury at least 30-inches below ground.

G. Test Wells: Minimum of two at each building/ structure ground loop, except as otherwise indicated on the Drawings. Set top of well flush with finished grade or floor. Fill the well bottom with 1-inch maximum-size crushed stone or gravel.

3.3 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Non-contact metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at both entrances and exits with the grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Each underground ductbank shall have a continuous ground wire as shown on the Drawings. All ductbank ground wires shall be exothermically connected in Manholes and Handholes to create continuous uninterrupted path for the ground cable.

B. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor. Make connections with minimum No. 4 AWG stranded, hard-drawn copper wire. Train conductors plumb or level around corners and support to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Grounding System: Ground Pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage an electrical testing organization to perform tests described below.

B. Test: Subject the completed grounding system to a resistance test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81

C. Maximum grounding to resistance values are as follows:
   1. Equipment rated 500 KVA and Less: 5 ohms.
   2. Unfenced Pad-Mounted Equipment: 5 ohms.
   3. Manhole Grounds: 5 ohms.

D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

E. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.

F. Report: Prepare test reports, certified by the testing organization, or ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.6 ADJUSTING AND CLEANING

A. Restore surface features, including vegetation, at areas disturbed by work in this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoil, fertilizer, lime, seed, sod, sprigs, and mulch. Comply with Section 02222 – Excavation, Trenching and Backfill. Maintain restored surface. Restore disturbed paving to the original condition.

END OF SECTION

SECTION 16111
CONDUIT
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SECTION 16111
CONDUIT

PART 1. GENERAL

1.1 SCOPE

A. Rigid metal conduit and fittings.

B. Intermediate metal conduit and fittings.

C. Flexible metal conduit and fittings.

D. Liquidtight flexible metal conduit and fittings.

E. Non-metallic conduit and fittings.

1.2 SUBMITTALS

Submit product data.

PART 2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Conduit: Allied, Republic, Triangle or Wheatland.

B. PVC Conduit: Amoco, Carlon or Certainteed.

C. Flexible Conduit: Anaconda, Thomas & Betts, Electrical Flex or Triangle.

D. Fittings: Appleton, Crouse-Hinds, Oz or Thomas & Betts.

E. Substitutions: Products equal to those listed.

2.2 RIGID METAL CONDUIT AND FITTINGS

A. Aluminum Conduit: UL 6; ANSI C80.1; aluminum; minimum size ¾-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; zinc coated; taper-threaded type, material to match conduit. Where PVC coated conduits are indicated all couplings, fittings, conduit bodies, pipe straps, U bolts, beam clamps, flex connections and other accessories shall have factory applied PVC coating. Use PVC coated hubs for connection of coated conduits - locknuts are not acceptable.

2.3 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

A. IMC: UL 1242; hot dip galvanized; minimum size ¾-inch.

B. Fittings and Conduit Bodies: Use fittings and conduit bodies specified above for rigid steel conduit.

2.4 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Conduit: UL 1; FS WW-C-566; single steel continuous strip with galvanized coating; minimum size 3/4-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; malleable iron squeeze type.

2.5 LIQUIDTIGHT FLEXIBLE CONDUIT AND FITTINGS

A. Conduit: UL listed liquidtight consisting of an extruded thermoplastic cover over a galvanized steel core. Minimum size ¾-inch. Exception: Where connected to devices with manufacturer supplied ½ or 3/8-inch hubs, match conduit size to hub size.

B. Fittings and Conduit Bodies: NEMA FB-1; galvanized steel compression type with O-ring. Where PVC coated conduits are indicated, provide PVC coated fittings for flex connections.

2.6 RIGID NONMETALLIC CONDUIT AND FITTINGS

A. Conduit: NEMA TC-2; Schedule 40 PVC, minimum size 1".

B. Fittings and Conduit Bodies: NEMA TC-3.

2.7 PVC-COATED RIGID GALVANIZED STEEL CONDUIT

A. Meet the requirements of NEMA RN 1.

B. Material:

- Meet requirements of NEMA C80.1 and UL 6.

- Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength than PVC.

- Interior finish: Urethane coating, 2-mil nominal thickness

C. Threads: Hot-dipped galvanized and factory coated with urethane.

D. Bendable without damage to interior or exterior coating

2.8 LIQUIDTIGHT FLEXIBLE NON-METALLIC CONDUIT AND FITTINGS

A. Conduit: UL listed, liquidtight consisting of a hand PVC spiral with flexible PVC covering. Minimum size is ¾-inch.

B. Fittings: UL listed, molded from high-strength, glass-filled thermoplastic.

PART 3. EXECUTION

3.1 CONDUIT SCHEDULE

A. Unless noted otherwise, all conduit shall conform to the following schedule:

1. All exposed conduits shall be rigid aluminum.

B. Use liquidtight flexible steel conduit for connections to motors, transformers and other vibrating equipment.

C. Non-jacketed flexible steel conduit may be used for connections to lighting fixtures in suspended ceilings.

D. Rigid nonmetallic conduit may be used for underground, concrete encased duct banks and in or below slab on grade. Exception: Use rigid steel or IMC conduit for analog signal circuits; 4 to 20 mA and AC or DC signals less than 25 volts.

E. Where PVC conduit is indicated, make a transition to rigid steel below grade or slab and continue above with rigid steel conduit. Exception: PVC may enter switchboards, motor control centers or other floor standing electrical equipment enclosures. Provide bell ends or socket end bell at enclosure entry.

3.2 CONDUIT ARRANGEMENT AND SUPPORT

A. Arrange conduit to maintain headroom and present a neat appearance. Runs exposed conduits parallel or perpendicular to building surfaces and adjacent piping. Group conduit in parallel runs where practical and provide rack space for 25 percent additional conduits. Use concentric bends for parallel runs.

B. Avoid sources of heat when possible. Where unavoidable, maintain 3-inch clearance when crossing hot pipes and 12-inch clearance between parallel hot pipes, flues, heating appliances and other heat sources.

C. Support conduits to prevent distortion of alignment by wire pulling operations. Fasten single conduits with one-hole malleable iron straps. For multiple runs use channel and clamps. Wire, perforated pipe straps and the like are not acceptable support means.

D. Support conduit at a maximum of seven feet on center and within three feet of each box, cabinet, or fitting. Hang trapeze assemblies with threaded rods not less than 1/2-inch diameter. Remove all temporary supports prior to pulling conductors.

3.3 CONDUIT INSTALLATION

A. Cut conduit square using a saw or pipecutter and de-burr cut ends. Paint threads with zinc compound. Bring conduit to the shoulder of fittings and couplings and fasten securely. All connections are to be wrench tightened and electrically continuous. No running threads are permitted.

B. Use conduit hubs for fastening conduit to cast boxes, and for fastening conduit to sheet metal boxes in damp or wet locations. Use conduit bodies to make sharp changes in direction. For sizes 2-inches and larger, use "LD" or similar fittings to permit a straight pull from either direction.

C. The maximum length between pull points is 400 feet. This length shall be reduced by hundred foot for every ninety-degree bend.

D. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2-inch size. Crushed or deformed conduits may not be installed.

E. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

F. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture. Install threaded PVC end caps on conduits stubbed up for future use.

G. Provide a 200-pound tensile strength polyolefin line pulled through and tied off at each end of all empty conduits.

H. Install expansion joints where conduit crosses building expansion or seismic joints and for straight runs in excess of 100 feet.

I. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.

J. Provide watertight seals, equal to OZ type WSK or FSK, where conduit penetrates exterior walls and where conduit passes between spaces normally at different temperatures. Seal duct bank and underground conduit entry with GE or Dow silicone sealant.

K. In locations where the conduit cannot be turned, provide three piece threaded rigid couplings. Provide clamp backs for conduits on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.

L. Route conduits below the slab.

M. Protect conduit threads from rust and damage during construction.

N. PVC Conduit Bends: Do not use methods which will deform or change the physical characteristics of the conduit. Use PVC-coated rigid steel factory elbows for bends in runs longer than 100 feet, and in runs which have more than two

bends, regardless of length. Exception: Where concrete encased in slab or ductbank, GRS elbows may be used in lieu of PVC coated.

O. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.

P. PVC Coated Conduit: Exercise care not to damage the coating during cutting, threading, bending, and assembly. Follow the manufacturer's installation instructions. Use vise jaws, bending equipment, strap wrenches, and other tools which are specifically designed for coated conduits. Do not use chain vise, pipe wrench, channel locks or the like. Nicks or small damaged areas (1/2-inch maximum) may be repaired with a manufacturer approved compound. Replace items if coating is damaged in excess of ½-inch.

Q. Conductor Protection: Provide bushings on metallic and bell ends on PVC conduit unless conduit terminates in a hub for similar fitting.

R. Where available, bond signal conduits directly to building ground grid.

3.4 UNDERGROUND DUCT BANK INSTALLATION

A. Install top of duct bank minimum 24-inches below finished grade with plastic warning tape 12-inches below finished grade.

B. Install conduit with minimum grade of 4-inches per 100 feet.

C. Terminate conduit in end bell at manhole entrys.

D. Stagger conduit joints in concrete encasement 6-inches minimum.

E. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank. Use suitable separators and chairs installed not greater than four feet on centers to provide conduit spacing as indicated. Securely anchor conduit to prevent movement during concrete placement.

F. Construct duct banks with 3,000 psi concrete. Provide steel reinforcing under the roadways and parking areas. Mix red oxide to the concrete.

G. Where duct bank passes beneath footings or slabs resting on grade excavate to provide a minimum of 6-inch clearance between the conduits and the structure. Backfill to the base of the structure with concrete.

H. Provide underground marking tape for early detection of buried power and communication lines.

END OF SECTION

SECTION 16119
UNDERGROUND DUCTS AND UTILITY STRUCTURES
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SECTION 16119
UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1. GENERAL

1.1 SCOPE

A. This Section includes underground conduits and ducts, duct banks, pull boxes and handholes, manholes, and other underground utility structures.

B. Products furnished and installed under this Section include pulling eyes, cable stanchions, cable arms, and insulators.

C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

D. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 02222 – Excavation, Trenching, and Backfill for general requirements for excavation, backfill and related items for ducts, manholes, and handholes.
   3. Section 03200 – Concrete Reinforcement and Dowelling.
   4. Section 03300 – Cast-In-Place Concrete for cast-in-place concrete requirements.
   5. Section 16195 – Electrical Identification.

1.2 REFERENCES

A. Publication listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. Industry Standards:
      a. American National Standards Institute, Inc. (ANSI).
         i. ANSI C2 – National Electrical Safety Code
         ii. ANSI C80 – Rigid Steel Conduit
      b. National Electrical Manufacturers Association, Inc. (NEMA).
         i. NEMA TC-2 – Rigid Nonmetallic Conduit
         ii. NEMA TC-3 – PVC Conduit and Tubing Fittings
      c. National Fire Protection Association (NFPA):
         i. NFPA 70 – National Electrical Code (NEC)
   2. Government Standards:
      a. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA). Code of Federal Regulations, Title 29, Chapter XVII
         i. 1910 – Part 1910, Subpart S, Electrical, Revised by CFR 4056, January 16, 1981.

ii. 1926 – Part 1926, Subpart K, Electrical, Revised by 51 CFR 25318, July 11, 1986.

1.3 SUBMITTALS

A. General: Submit the following according to the requirements of Section 01300 - Submittals.

B. Product data for metal accessories for manholes and handholes, conduit and duct, duct bank materials, and miscellaneous components.

C. Field test reports indication and interpreting test results relative to compliance with performance requirements of Paragraph 3.06, “Field Quality Control” Article in Part 3 of this Section.

D. Record Documents: Show dimensioned locations of underground ducts.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, and ANSI C2 for components and installation.

B. Listing and Labeling: Provide products that are UL listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms “Listed” and “Labeled”: As defined in the “National Electrical Code”, Article 100.

C. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities as determined in the field.

D. Coordinate elevations of duct and duct bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to manholes and handholes, and as approved by the Engineer.

1.5 DEFINITIONS

A. Duct: PVC conduit used underground, embedded in concrete (under road and parking areas, and for service entrance ductbanks).

B. Duct Bank: 2 or more PVC conduits installed underground in the same concrete envelope.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

PART 2. PRODUCTS

2.1 CONDUIT AND DUCT MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the Work include:

1. Nonmetallic Ducts:
   a. CANTEX, Inc.
   b. Carlon; Lamson & Sessions Company.
   c. Pipe & Plastic Group; Certainteed Products Corp.
   d. Or approved equal.

2.2 CONDUIT AND DUCT

A. Rigid Steel Conduit: ANSI C80.1, galvanized.

B. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, rated for use with 105oC conductors under all installation conditions. Suitable for above ground, direct burial, concrete encased, and direct sunlight applications, ASTM class DB (suitable for direct burial without concrete encasement). Use Schedule 80 PVC for locations subject to damage.

C. PVC Conduit and Tubing Fittings: NEMA TC3.

2.3 CONDUIT AND DUCT ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacing and concrete cover depths indicated, while supporting ducts during covering.

B. Duct Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35^{o}F, withstands temperature of 300^{o}F without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheathes, cable jackets, insulation materials, and the common metals.

2.4 CONDUIT AND DUCT CONSTRUCTION MATERIALS

A. Concrete: Conform to Section 03300 - Cast-In-Place Concrete for concrete and Section 03300 – Concrete Reinforcement and Dowelling, for reinforcing steel.

1. Strength: Class B 3000 psi (20.7 Mpa) minimum 28-day compressive strength.
2. Aggregate for Duct Encasement: 3/8-inch maximum size.

2.5 MANHOLE AND HANDHOLE MANUFACTURERS

A. Acceptable Manufacturers:

1. Old Castle precast, Inc.
2. Brooks Products Co.

3. Jensen Precast Products.
4. Or approved equal.

2.6 MANHOLE AND HANDHOLE CONSTRUCTION MATERIALS

A. Concrete: Where applicable, conform to Section 03300 - Cast-In-Place Concrete, for concrete and reinforcing.
   1. Strength: 3000 psi (20.7 Mpa) minimum 28-day compressive strength.
   2. Aggregate for Duct Encasement: 3/8-inch maximum size.

B. Concrete Reinforcement: All underground structures, including duct banks, shall utilize concrete reinforced with rebar. Intent is for rebar details to be in accordance with the requirements of Section 03200 – Concrete Reinforcement and Dowelling, and / or electrical details as shown on the Contract Drawings. In the details in Contract Drawings, structure and duct bank rebar shall be #4 steel rebar. Install rebar continuously near all the structure's or duct bank's top and bottom edges and corners, with additional #4 rebar spaced such that maximum spacing between rebars is 18-inches. Additionally, duct banks shall have #4 rebar placed across the top and bottom of the bank, every 18-inches, for the entire length of the duct bank.

2.7 MANHOLES AND HANDHOLES

A. Cable racks, supports, pulling-in-irons, manhole steps and hardware shall be hot dipped galvanized steel as manufactured by Line Materials Co. or approved equal.

B. Precast concrete manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load. Precast manholes and handholes shall be as manufactured by Old Castle Precast, Inc., or approved equal.

C. Manhole frames and covers shall be cast-iron heavy-duty type for class H-20-wheel loading, and shall be as manufactured by Neenah, or equal. Manhole covers shall be marked Electrical Medium Voltage or Electric Low Voltage as applicable, in addition stamp the manhole covers with minimum 1-1/2-inch high letters and numbers for manhole identification. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

D. Handhole covers and frames shall be hot dipped galvanized and designed for a Class H-20-wheel load. Handhole covers and hatches shall have Type 316 stainless steel security bolts. Handhole covers shall be marked Electric Medium Voltage or Electric Low Voltage as applicable, in addition stamp the handhole covers with minimum 1-1/2-inch high letters and numbers for handhole identification. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

E. Bell ends and plastic duct spacers shall be as manufactured by Carlon or approved equal.

F. Manholes and Handholes shall be installed to permit passive drainage of infiltration seepage as detailed on the Drawings. In the absence of such detail, provide 3-inch diameter PVC sleeve at low point of structure extending to a depth approximately 12-inches below the bottom surface of the structure. Provide a finely crushed and packed stone base below the structure to a total depth approximately 24-inches below the structure bottom to permit drainage. Provide drain cover at pipe termination in structure.

PART 3.EXECUTION

3.1 APPLICATION

A. Underground Ducts for Electrical Utility Service: Plastic conduit encased in concrete.

B. Underground Ducts for Electrical Feeders: Plastic conduit encased in concrete.

C. Underground Ducts for Telephone Utility Service: Plastic conduit encased in concrete.

D. Underground Ducts for Communication Circuits: Plastic conduit encased in concrete.

3.2 EXAMINATION

A. Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 EARTHWORK

A. Excavation and Backfill: Conform to Section 02222 - Excavation, Trenching, and Backfill, but do not use heavy-duty, hydraulic-operated compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing or dirt, cable lay, and other work. Restore vegetation and include necessary topsoil, fertilizing, liming, seeding, sod, sprigging, or mulching.

C. Restore disturbed paving to the original condition.

3.4 CONDUIT AND DUCT INSTALLATION

A. Install Non-metallic conduit and duct as indicated according to manufacturer’s written instructions.

B. Slope: Pitch ducts minimum of 4-inches per 100-feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and require duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18-inches into the concrete on both sides of joint near the corners of the envelope.
3. Reinforcing: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use forms.
5. Minimum Clearances between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
6. Depth: Except as otherwise indicated, install top of duct bank at minimum of 18-inches below finished grade in general areas and at maximum of 30-inches below finished grade in vehicular traffic areas.
7. Install identification marker tape in accordance with Section 16195 – Electrical Identification.
8. Run #1/0 bare copper grounding conductor in all concrete encased duct banks.

F. Pulling Cord: Install 100-pound-test nylon cord in ducts, including spares.

G. Building Entrances: Transition from underground duct to conduit 10-feet minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcing in duct banks. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.

2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight

H. Overall underground electrical ductbanks are shown on the electrical site plans. Final stub-up locations (entry/exit) into equipment inside electrical rooms and at each site area shall be field coordinated and determined by contractor.

I. Equipment drawings shall be used to determine where embedded conduits may be stubbed-up at or beneath equipment. For all embedded conduits contractor shall determine routing of conduit based on site conditions.

J. Conduits embedded in concrete slab shall not interfere with equipment or building structures. Interferences with embedded conduits stubbed-up at or beneath equipment shall also consider accessibility at such equipment. Interferences with embedded conduits shall be the contractor's responsibility and cost to remedy.

K. Spare empty conduits shall be installed embedded in slabs as required, and as part of underground ductbanks.

3.5 MANHOLE AND HANDHOLE INSTALLATION

A. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

B. Install pulling-in irons opposite all raceway entrances to manholes. Pulling irons shall be cast into the walls and floor. Bolt on style pulling irons are not acceptable.

C. Cables shall be completely looped and trained in manholes and supported on racks and hoods at intervals not greater than 3-feet 0-inches and supports shall be installed on each side of all splices.

D. Furnish cast in place inserts on all manhole walls for mounting future racks as well as racks required for present installation.

E. Manhole covers in streets shall finish flush with finished paving and in other areas shall finish 3-inches above crown adjacent roadway.

F. Floor elevations of manholes shall be so set that the center line of the lowest conduit entering will be not less than 1-foot below the roof slab or top.

G. A 3/4-inch by 10-foot copperclad ground rod shall be driven in the bottom of each manhole. All bond wires, galvanized conduits and metal cable racks shall be bonded to the ground rod.

H. Polyethylene warning tape shall be provided for all underground raceways, duct banks, etc.

I. Install a bare copper cable in the concrete encased duct bank. Size shall be as shown on the Drawings. In the absence of cable size being shown on the Drawings, it shall be #1/0. It shall be continuous from one end to the other for the entire length of the ductwork and shall be bonded to building steel on each end and to all manhole-handhole ground loops and associated manhole-handhole ground rods.

J. Install expansion deflection fittings as required by the NEC and duct bank raceway manufacturer.

K. Record drawings shall be furnished showing each conduit termination, elevations, locations, manholes, etc.

3.6 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
2. Duct Integrity: Rod ducts with a mandrel 1/4-inch smaller in diameter than internal diameter of ducts. Where rod indicates obstructions in ducts, remove the obstructions and retest.

B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.7 CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2-inch greater than internal diameter or duct.

END OF SECTION

SECTION 16120
CONDUCTORS AND CABLES
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SECTION 16120
CONDUCTORS AND CABLES

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Building wire

B. Cable.

C. Wiring connections and terminations.

1.2 SUBMITTALS

A. Submit product data.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Conductors: Equal to Aetna, Continental, Okonite, Pirelli, Southwire or Triangle.

B. Signal Circuit Conductors: Equal to Belden, Continental, Dekoron or Penn.

C. Connectors: Equal to Thomas & Betts, Ideal or OZ.

D. Pulling Compounds: Water soluble, equal to Polywater J.

E. Wire and Cable Markers: Plastic, split sleeve or tubing type, equal to Brady Type XC or T & B Type SM.

2.2 EQUIPMENT

A. Building Wire

1. Thermoplastic Insulated Building Wire: NEMA WC-5.
2. Cross-linked polyethylene- insulated.
3. Feeder and Branch Circuits: Single stranded conductor; 98% conductivity copper; 75/90ºC; 600-volt PVC insulated with nylon jacket; type THWN/THHN. Minimum size #12 AWG.
4. Feeder Conductors larger than 250 KCMIL; single stranded conductor copper; 90ºC; 600-volt; flame retardant moisture resistant cross-linked polyethylene insulated; type XHHW-2; minimum size 300 KCMIL.

5. Control Circuits: Same as specified above for feeder and branch circuits, except minimum size #14 AWG.

B. Remote Control And Signal Cable

1. Control Cable for Class I Remote Control and Signal Circuits: Copper conductor; 600-volt insulation, rated 60 degrees C; individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
2. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
3. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, individual conductors twisted together, shielded, and covered with a fluoropolymer jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.
4. Instrumentation Signal Cables: #16 AWG stranded tinned copper conductors; 600-volt polyethylene insulation; twisted pair or three conductor construction; 100 percent coverage aluminum polyester shield; #18 stranded tinned copper drain wire; vinyl outer jacket; UL listed.

C. Shielded Power Cables

Shielded Power Cable shall be used between all VFDs and associated motors.

1. Type shielded power cable shall consist of multiple shielded 98% conductivity copper conductors type TC cable. The conductor insulating material shall be chemically cross-linked polyethylene UL rated VW -1 with 90°C continuous rating in wet or dry locations, 130°C emergency overload rating, 250°C short circuit rating.
2. Cable shall have sheath with close fitting, impervious, continuous, welded, corrugated aluminum C-L-X per UL 1569.
3. The cable shall have bare stranded copper grounding conductor per ASTM B-8, Class B in accordance with UL 1581.
4. The cable shall be suitable for cable tray use, sunlight resistant, and shall be provided in the sizes and conductor numbers shown in the cable schedule.

PART 3. EXECUTION

3.1 INSTALLATION

A. General Wiring Methods

1. Use only stranded conductors. Exception: Solid conductors size #12 and #10 AWG may be used for receptacle branch circuit wiring.
2. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet.
3. Place an equal number of conductors for each phase of a circuit in same raceway or cable.
4. Identification: All conductors shall be identified throughout the electrical system. For control and signal conductors use wire markers at all terminals and connections. Color code power circuit conductors as follows:

	120/208 Volt System	277/480 Volt System
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow

	120/208 Volt System	277/480 Volt System
Neutral	White	Grey
Ground	Green	Green

5. Do not splice high voltage cables without written approval from Owner’s representative.
6. For conductors #8 AWG and larger color coding may be accomplished with 1-inch wide colored tape applied at each end of the conductor or at points where conductor is accessible so as to be visible inside the enclosure.
7. Neatly train and lace wiring inside boxes, equipment and panelboards. Support to prevent conductor movement under fault conditions.
8. Fireproofing: Wrap each 5 kV phase conductor with fireproof tape in manholes and pullboxes.

B. Wiring Installation In Raceways

1. Unless otherwise indicated, install all conductors in conduit.
2. Pull all conductors into a raceway at the same time. Thoroughly swab raceway system before installing conductors. Use wire pulling lubricant for all pulls. Do not exceed the manufacturer's pulling tension.
3. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Installation In Manholes

1. Rack all cables; straight thru pulls are not acceptable.
2. Attach cables to rack supports with tie wraps to prevent motion under fault conditions.

D. Wiring Connections And Terminations

1. Avoid unnecessary splices. Splice only in accessible junction or outlet boxes.
2. Make connections to circuit breakers, disconnect switches, panel mains, etc. with solderless lugs.
3. Use mechanical connectors for splices, taps, fixture and motor connections. Exception: Square thread helical spring plastic cap (wire nut) type connectors are acceptable for solid conductor splices and taps.
4. Use insulated throat, spade type crimp on connectors for strap screw device terminals. Exception: Receptacle back wiring provisions may be used for terminating solid conductors.
5. Where possible use connectors with integral, insulating covers. Otherwise tape uninsulated conductors and connectors to 150 percent of the insulation value of conductor.
6. High Voltage Connections and splices: Performed by a certified cable splicer. Notify the Engineer prior to making high voltage termination or splices. The engineer reserves the right to inspect splicing and termination procedures. Tag all connections with splicers name and date. Ground shield with #6 AWG minimum.
7. Thoroughly clean wires before installing lugs and connectors.
8. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

3.2 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage and proper connection.

B. Torque test conductor connections and terminations to manufacturer's recommended values.

C. Continuity Tests: Ring all conductors for continuity and replace any open conductors.

D. Ground Fault Tests: Meggar all feeder circuits for grounds. Compile and submit a list of meggar readings. Replace all conductors measuring less than 2 megohms to ground.

E. High Voltage Ground Fault Tests: DC high pot tests performed by an independent testing agency and certified by a professional engineer registered in the State of Georgia. Conduct test at 80 percent of the factory test voltage for five minutes

minimum after cable has been brought up to test voltage. Record leakage current at one-minute intervals. Replace conductors with leakage current differing significantly from other conductors and conductors with leakage current values which do not fall or fall and level off during the test. Engineer reserves the right to require a re-test if leakage currents are more than twice the values calculated using the manufacturer's data. The system may not be energized at primary voltage until cable test has been approved by the engineer.

END OF SECTION

SECTION 16130

ELECTRICAL BOXES AND FITTINGS

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SECTION 16130

ELECTRICAL BOXES AND FITTINGS

PART 1. GENERAL

1.1 SCOPE

A. Work includes furnishing, labor, materials and equipment, tools and incidentals for complete electrical boxes and fittings

B. Work in this Section includes:

1. Outlet boxes.
2. Pull and junction boxes.

C. Related Sections include but are not limited to:

1. Section 01300 – Submittals.
2. Section 16160 – Cabinets and Enclosures.

1.2 REFERENCES

A. Publication listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.

1. National Electrical Manufacturers Association (NEMA).
   a. NEMA – Electrical Codes.
   b. NEMA OS-1 – Sheet- Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
   c. NEMA A250 – Enclosures for Electrical Equipment.
2. Underwriter Laboratories Inc. (UL).
   a. UL 886 – Standard, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
3. American National Standards Institute (ANSI).
   a. ANSI A117.1 – Standard on Accessible and Useable Buildings and Facilities.
   b. ANSI C33.27 – Safety Standard for Outlet Boxes and Fittings for Use in Hazardous Locations, Class I, Group A, B, C, and D, Class II Groups E, F, and G.
4. National Electrical Code (NEC).

1.3 SUBMITTALS

A. Submit product data.

PART 2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Outlet Boxes: Appleton, Crouse Hinds, Raco, Steel City, Thomas & Betts or accepted equal.

B. Pull and Junction Boxes: Appleton, Crouse Hinds, Hoffmann, Weigmann or accepted equal.

2.2 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS-1; galvanized steel, with 1/2-inch male fixture studs where required.

B. Cast Boxes: Cast feralloy with galvanized or corro-free epoxy finish, deep type, gasketed cover, threaded hubs.

2.3 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS-1; galvanized steel. Boxes larger than 12-inches in any dimension are hinged enclosure as specified under Section 16160 - Cabinets and Enclosures.

B. Cast Metal Boxes: NEMA 250; Type 4, galvanized cast iron box and cover, neoprene gasket, stainless steel cover screws, UL listed as raintight. Provide flat-flanged type for surface mounting and outside flange recessed cover type for underground use. Boxes for sidewalk or other traffic areas to have appropriate duty cover with non-skid finish.

C. Corrosion Resistant (NEMA 4X) Boxes: Stainless steel, gasketed screw cover. For boxes larger than 12-inches in any dimension provide hinge on one (1) side and trunk latches on the other three (3) sides.

D. PVC Coated Rigid Steel Boxes: Galvanized rigid steel with Factory applied external 40 mil PVC coating and urethane interior coating.

2.4 HAZARDOUS AREAS - OUTLET, PULL AND JUNCTION BOXES

A. Boxes in hazardous areas shall be cast iron with galvanized or corro-free epoxy finish, threaded hubs and cover, and shall comply with UL 886, ANSI C 33.27 and with NEC Class I, Div. 1 and Div. 2, Group D hazardous locations.

PART 3. EXECUTION

3.1 COORDINATION OF BOX LOCATIONS

A. Provide boxes as shown on Drawings, and as required for splices, taps, wire pulling, and equipment connections.

B. Box locations shown on the Drawings are approximate unless dimensioned. Verify box locations prior to rough-in. Locate outlet boxes to permit handicap access per ANSI A117.1. Any outlet may be relocated by up to 10-feet horizontally before it is permanently installed without incurring additional cost to the Owner.

3.2 INSTALLATION

A. Support boxes independently of conduit.

B. Use multiple-gang boxes where more than one (1) device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

C. Align wall-mounted outlet boxes for switches, thermostats, and similar devices. Align adjacent devices at different elevations in one (1) vertical line. Set floor boxes level and flush with finish flooring material.

D. Provide cast outlet boxes in exposed, exterior, hazardous and wet locations.

E. Use PVC coated rigid steel boxes wherever PVC coated conduit is indicated.

F. Box covers shall be of the same material and construction as the box.

END OF SECTION

SECTION 16141
WIRING DEVICES
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SECTION 16141

WIRING DEVICES

PART 1. GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing labor, materials and equipment, tools and incidentals for complete and operable wiring devices.

B. Work in this Section includes:

1. Wall switches.
2. Receptacles.
3. Device plates and box covers.

C. Related Sections include, but are not limited to:

1. Section 01300 – Submittals.
2. Section 16010 – General Electrical Requirements.

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.

1. National Electrical Manufacturers Association (NEMA).
   a. NEMA WD-1 – General Color Requirements for Wiring Devices.
   b. NEMA WD-5 – Dimensional Specification.
2. Underwriters Laboratories Inc. (UL).
   a. UL 886 – Outlet Boxes and fittings for Use in Hazardous (Classified) Locations.
   b. UL 1010 – Plug Combinations for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Submit product data, in accordance with the requirements of Section 01300 - Submittals.

PART 2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS FOR NON-HAZARDOUS AREAS

A. Switches and Receptacles: Arrow Hart, Bryant, Hubbell, Leviton SpecMaster, Pass and Seymour, Sierra, Crouse-Hinds, Appleton, TayMac or accepted equal.

B. Wall Plates: TayMac; Specification Grade, or accepted equal.

C. For acceptable manufacturers in hazardous areas, see Paragraph 2.04.

2.2 SWITCHES AND RECEPTACLES

A. Wall Switches: NEMA WD-1; FS W-S-896; 20 amp, 120/277 volt, specification grade; horsepower rated; quiet type; back and side wiring provisions; toggle handle.

B. Convenience Receptacles: NEMA WD-1; FS W-C-596; 20 amp, 125 volt, specification grade; impact resistant nylon face; back and side wiring provisions; grounding screw.

C. Specific Use Receptacles: NEMA WD-1 or WD-5; type as indicated. For branch circuits serving a single device, match device rating to branch circuit rating.

D. Device Colors: Brown in unfinished areas and ivory in finished office areas. Isolated ground circuits shall be orange.

2.3 WALL PLATES

A. Interior Finished Areas Device Plates: Type 302 stainless steel, 0.030-inch thick minimum, satin finish.

B. Interior Unfinished Areas Device Plates: Cast Iron Cover with Gasket and with galvanized finish.

C. Weatherproof Cover Plate: Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked Suitable For Wet Locations While In Use. Cover shall be UL listed. There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base to assure proper seal.

2.4 HAZARDOUS AREAS

A. Switches: Factory sealed enclosure, cast iron alloy body, single gang 3-way or 4-way, 20 amperes, 120 volt suitable for Class I, Div. 1 & Div. 2, Group D. Crouse-Hinds type EDS or accepted equal.

B. Convenience Receptacles and Plugs: Dead front, factory sealed, delayed action circuit breaking angle type, 2-wire, 3-pole rated 20 ampere, 125 volt, complying with UL1010 and suitable for Class I, Div. 1 & Div. 2, Group D hazardous areas. Crouse-Hinds CPS 152 with mating plug CPP, or accepted equal.

C. Power Receptacles and Plugs: Dead front interlocked with built-in rotary switch, 3-wire, 4 pole, 60 ampere, 480 volt, complying with UL 886, UL 1010 and suitable for Class I, Div. 1 & Div. 2 , Group D hazardous areas. Russell Stolls Cat. # 4264BC with mating plug Cat. # 4268BC, or accepted equal.

PART 3. EXECUTION

3.1 INSTALLATION

A. Secure devices to outlet boxes without depending on device plates to pull them tight. Install a bonding jumper between all devices and outlet boxes.

B. Install switches with off position down; and receptacles with grounding pole on bottom.

C. For cord and plug connected equipment, coordinate receptacle configuration with equipment supplied.

D. Install device plates on switch, receptacle, and blank outlets. Use jumbo size plates for devices installed in masonry walls.

END OF SECTION

SECTION 16155
MOTOR STARTERS
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SECTION 16155
MOTOR STARTERS

PART 1. GENERAL

1.1 SCOPE

A. Provide motor starters and motor control centers as specified herein and shown on the drawings.

B. Work covered by this section includes furnishing all labor, equipment, and materials required to install motor starter enclosures and motor control centers.

C. The electrical rooms have been sized based on Cutler-Hammer or GE's equipment. If an alternate manufacturer is used, the contractor shall take responsibility that the alternate manufacturer's equipment will fit the space. Electrical room layouts will also be required to be submitted for alternate manufacturer.

1.2 SUBMITTALS

A. Itemized bill of materials.

B. Descriptive information.

C. Dimensional layout drawings.

D. List of starters, feeders, and type of circuit protection and trip settings.

E. Complete wiring and schematic diagrams.

F. One-line diagrams.

G. Spare parts data.

H. Operations and maintenance manuals.

1.3 REFERENCES

A. Underwriter's Laboratories, Inc. (UL).

B. National-Electrical Manufacturer's Association (NEMA).

C. American National Standards Institute (ANSI).

D. National Fire Protection Association (NFPA).

PART 2. PRODUCTS

2.1 MOTOR STARTERS

A. Motor starters shall be full voltage, non-reversing (FVNR), combination MCP magnetic motor starters unless otherwise shown on the contract drawings. The starters shall be NEMA size 1 or larger.

B. Enclosures shall be NEMA 12 for indoor dry areas, NEMA 4X stainless steel for indoor corrosive areas and outdoor use.

C. Motor Circuit Protector (MCP) with 65,000 sym I.C. at 480 volts unless otherwise shown on the Drawings. Current limiters shall be used where necessary.

D. ABB / GE, Schneider Electric, Allen-Bradley, Eaton or approved equal.

E. Three, ambient temperature compensating, Class 20 solid state - manual reset shall be provided on all motor starters.

F. 120-volt control power transformer with 100 VA extra capacity and fuses, push-to-test run light (red), auxiliary normally open contact for use with data logging system, provide on-off selector switch, or start-stop push-buttons or hand-off-automatic switches and other control devices and indicating lights as shown on the electrical drawings.

G. Manually operated starters for single-phase fractional horsepower motors shall be full-voltage, non-reversing with overload protection. Provide red run indicating light and auxiliary contact for interlocking.

2.2 VARIABLE FREQUENCY DRIVES (VFD)

See Spec 16489 for VFD details.

PART 3. EXECUTION

3.1 INSTALLATION AND FIELD TESTING

A. Install equipment in accordance with submittal drawings and manufacturer's recommendations.

B. Make adjustments and settings in accordance with the short circuit and coordination study results.

END OF SECTION

SECTION 16160
CABINETS AND ENCLOSURES
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SECTION 16160
CABINETS AND ENCLOSURES

PART 1. GENERAL

1.1 SCOPE

A. Hinged cover enclosures.

B. Cabinets.

C. Terminal blocks and accessories.

1.2 SUBMITTALS

A. Submit product data.

B. Shop Drawings for Equipment Panels: Include schematic diagram, wiring diagram, outline drawing and construction diagram as described in NEMA ICS-1.

PART 2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cabinets and enclosures shall be equal to Crouse Hinds, Hoffman or Weigmann.

2.2 HINGED COVER ENCLOSURES

A. Construction: NEMA 250; 10-gauge steel, no knockouts, wall mounted or free-standing as indicated. Free-standing enclosures are minimum 20-inches deep. Unless otherwise noted, enclosures are NEMA 1A for indoor dry locations, NEMA 12 for indoor process area and NEMA 4X for outdoor, wet or damp locations.

B. Finish: Baked on enamel over a rust inhibitor.

C. Covers: Continuous hinge, held closed by hasp and staple for padlock. Furnish three-point latch for free standing enclosures.

D. Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.

2.3 CABINETS

A. Cabinet Boxes: Code gage galvanized steel. Provide ¾-inch thick plywood backboard painted matte white, for mounting terminal blocks.

B. Cabinet Fronts: Steel, surface type with concealed trim clamps, conceal hinge; finish in gray baked enamel.

2.4 TERMINAL BLOCKS AND ACCESSORIES

A. Terminal Blocks: NEMA ICS-4; UL listed.

B. Power Terminals: One-piece phenolic closed-back type, with binding screw or stud terminal connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, channel mounted with marking strip; screw terminals, rated 300 volts

2.5 FABRICATION

A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS-6.

B. Selectors and Indicators: Door mounted for indoor enclosures. For outdoor enclosures provide a separate, hinged, inner door (dead from panel) for device mounting.

C. Lace conductors with plastic ties to present a neat and orderly appearance. Provide nylon wrapping to protect conductors crossing hinges.

D. Provide protective pocket inside front cover with control wiring and panel layout diagrams.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install cabinets and enclosures plumb, anchor securely to wall and structural supports at each corner, minimum.

B. Provide necessary feet for free-standing equipment enclosures.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes identification of electrical materials, equipment, and installations.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

C. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 16010 – General Electrical Requirements.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.
   2. American National Standards Institute (ANSI).
      a. ANSI A13.1 – Standard for Pipe Identification.

1.03 SUBMITTALS

A. General: Submit each item in this Section according to Section 01300 - Submittals.

B. Product Data for each type of product specified.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work:
   1. American Labelmark Co., Labelmaster Subsidiary.
   2. Brady USA Inc.; Industrial Products Div.
   3. Carlton Industries, Inc.
   4. Champion American, Inc.
   5. Cole-Flex Corp.
   6. Ideal Industries, Inc.
   7. Markal Corp.
   8. National Band & Tag Co.
   9. Panduit Corp.
   10. Seton Name Plate Co.
   11. Standard Signs, Inc.
   12. Or approved equal.

2.02 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Engraving stock, melamine Plastic laminate, 1/16-inch minimum thickness for signs up to 20 sq. in., 1/8-inch thick for larger sizes.
   1. Engraved Legend: White letters on black face.
   2. Punched for mechanical fasteners.

C. Metallic signs for Exterior Use: Preprinted brass or aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for the application. 1/4-inch grommets in corners for mounting.

D. Laminated plastic signs for Interior Use: Engraved three layer laminated plastic, white letters on a black background. Use laminated phenolic engraving.

D. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.03 WIRE MARKERS

A. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The figures shall be 1/8-inch high. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation. The sleeves shall be shrunk to fit the

conductor with hot air after installation. They shall be TMS Thermofit Marker System by Raychem Co., W. H. Brady Co., or approved equal. Adhesive strips are not acceptable. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

2.04 RACEWAY MARKERS

A. Raceway markers shall be 0.036-inch minimum thickness, solid metal tags with raceway number stamped in 3/16-inch minimum height characters. Such tags shall be attached to the raceway with heavy duty tie wraps. Alternatively, aluminum wrapped bands, approved for the purpose, may be employed

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, colors, and Graphics: coordinate names, abbreviations, colors, and designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material and oily films before applying.

F. Install circuit identification labels on faceplates of receptacles, outlet, telephone/data outlets, etc. Use pressure sensitive, self-adhesive plastic labels. Identify supply panel and circuit on the label.

G. Install Circuit Identification Labels on Boxes: Label externally as follows:
   1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
   2. Concealed Boxed: Plasticized card-stock tags.
   3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

H. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6-inch to 8-inch below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width or 16-inches, use a single line marker.

I. The followingcolor codes shall be used for plastic line markers installed directly above underground lines:

Blue: Communications, Telephone, Data, Fire and Security

Red: 150V to 600V (lighting, power, controls)

Yellow: 601V to 15kV (medium and high voltage)

Note: Colors green, orange and white shall not be used for plastic line markers.

J. Color-Code Conductors: Primary service, secondary service, feeder, and branch circuit conductors throughout the electrical system.
   1. 208/120-V System: As follows:
      a. Phase A. Black.
      b. Phase B.: Red.
      c. Phase C: Blue
      d. Neutral: White.
      e. Ground: Green.
   2. 480/277-V System: As follows:
      a. Phase A: Yellow.
      b. Phase B: Brown.
      c. Phase C.: Orange.
      d. Neutral: Gray.
      e. Ground: Green.
   3. Medium Voltage System: Color code phases A, B and C to match Georgia Power recommendations.
   4. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu of factory-colored wire for sizes larger than No. 10 AWG. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6-inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

K. Power Circuit Identification: Use plastic laminated for cables, feeders, and power circuits in vaults, pull boxes junction boxes, manholes, and switchboard rooms.
   1. Legend: 1/4-inch letter and number with legend corresponding to indicated circuit designations.
   2. Fasten tags with nylon cable ties.
   3. Apply tags or bands such that all conductors in each circuit are included.

L. Apply identification to conductors as follows:
   1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

M. Wire and Cable Identification
1. Every power wire, power cable, control wire, control cable, instrumentation wire and cable shall be permanently identified at every termination point with a wire marker.
2. Use wire marker as described in Paragraph 2.03 above. Mark with circuit wire number, control diagram number, loop number, equipment number, etc. as applicable.

N. Apply warning, caution, and instruction signs and stencils as follows:
1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

O. Nameplates:
1. Apply equipment nameplates of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/2-inch high lettering on 1 1/2-inch high label: where 2 lines of text are required, use lettering 2-inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.
    a. Panelboards, electrical cabinets, and enclosures.
    b. Power transfer equipment.
    c. Contactors.
    d. Transformers.
    e. Fire-alarm master station or control panel.
    f. Telephone Backboard.
    g. Data Backboard.
2. Equipment nameplates shall also be applied for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3. Equipment nameplate shall include plant area identifier and specific equipment number as shown on power and MCC single line diagrams.

P. Identification Labels

1. Junction boxes shall includepermanent plastic labels, yellow with black text. Except as otherwise indicated, provide a single line of text with 1/2-inch high lettering on 1 1/2-inch high label: where 2 lines of text are required, use lettering 2-inches high. Identification labels shall include voltage class or services as follows:

   Comm – Communication/Data

   Tele – Telephone

   Control – 120V Control

   Inst – Instrumentation

   Motor – 600V motor branch circuit

   Power – 600V power and feeder circuit

   Note: lighting and receptacle junction boxes require no identification.

END OF SECTION

SECTION 16231
GENERATOR AND ATS
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SECTION 16231
GENERATOR AND ATS

PART 1 – GENERAL

1.1 REFERENCES

The equipment covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards of ANSI, NEC, ISO, U.L., IEEE and NEMA.

1.2 RELATED SECTIONS

A. Division 3 - Concrete

B. Division 15 – Mechanical

1.3 WORK INCLUDED

A. The work includes supplying a complete integrated emergency generator system. The system consists of a diesel generator set with related component accessories and Automatic Transfer Switch as specified herein.

B. The Contractor shall provide a full tank of diesel fuel for the completion of all testing.

C. A complete system load test shall be performed after all equipment is installed.

D. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a Manufacturer who has 25 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.

1.4 MANUFACTURERS

A. There shall be one source responsibility for warranty, parts and service through a local representative with factory trained service personnel.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Generator Set
   a. Caterpillar
   b. Cummins-Onan
   c. Generac
   d. Kohler
2. Automatic Transfer Switch
   a. Asco

b. Hubbell
c. Cummins-Onan

1.5 SUBMITTALS

A. Engine-generator submittals shall include the following information

1. Factory published specification sheet indicating standard and optional accessories, ratings, etc.
2. Manufacturer's catalog cut sheets of all auxiliary components such as Automatic Transfer Switches, battery charger, control panel, enclosure, main circuit breaker, etc.
3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.
4. Weights of all equipment.
5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.
6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, jacket water heater, remote alarm indications.
7. Engine mechanical data including heat rejection, exhaust gas flows, combustion air and ventilation air flows, noise data, fuel consumption, etc.
8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
9. Generator resistances, reactances, and time constants.
10. Generator motor starting capability.
11. Control panel schematics.
12. Oil sampling analysis, laboratory location, and information.
13. Manufacturer's and dealer's written warranty.
14. Letter of guarantee that the proposed generator will be capable of starting and running the loads specified on the drawings.

1.6 WARRANTY

A. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of substantial completion and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made

unusable by the defect) used during the course of repair. Submittals received without written warranties as specified will be rejected in their entirety.

1.7 PARTS AND SERVICE QUALIFICATIONS

A. The engine-generator supplier shall have service facilities within 75 miles of the project site and maintain 24-hour parts and service capability. The distributor shall stock parts as needed to support the generator set package for this specific project.

B. The dealer shall maintain qualified, factory trained service personnel that can respond to an emergency call within 4 hours of notification, 24 hours per day.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The generator set shall be Standby and have a kW rating as shown on the one line diagram. The additional ratings shall be 1800 RPM, 0.8 power factor, 480Y/277 VAC, 3 phase, 4 wire, 60 hertz, including radiator fan and all parasitic loads.

B. Generator maximum voltage dip shall be 25% with maximum frequency dip of 10%.

C. All materials and parts comprising the unit shall be new and unused.

2.2 DIESEL ENGINE

A. The engine shall be water-cooled inline or vee-type, four cycle compression ignition diesel. It shall meet specifications when operating on number 2 domestic burner oil. Two cycle engines will not be considered. The engine shall be equipped with fuel, lube oil, and intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, service meter, gear-driven water pump.

B. The complete engine block shall be machined from one casting. Designs incorporating multiple blocks bolted together are not acceptable.

C. The engine shall utilize a gear-type, positive displacement, full pressure lubricating oil pump and water-cooled lube oil cooler. Pistons shall be spray-cooled. Provide oil filters, oil pressure gauge, dipstick and oil drain.

D. Fuel filter and serviceable fuel system components shall be located to prevent fuel from spilling onto generator set batteries.

E. The engine shall be equipped with an isochronous electronic governor to maintain 0% droop from no load to full load and +/- 0.25% steady state frequency variation. The governor shall be equipped with speed adjustment.

2.3 GENERATOR

A. The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling.

B. The insulation material shall meet NEMA standards for Class H insulation and be vacuum impregnated with epoxy varnish to be fungus resistant. Temperature rise of the rotor and stator shall not exceed NEMA class F (130° C rise by resistance over 40° C ambient). The excitation system shall be of brushless construction.

C. The brushless exciter shall be independent of main stator windings (either permanent magnet or auxiliary windings) and shall consist of a three-phase armature and a three-phase full wave bridge rectifier mounted on the rotor shaft. Surge suppressors shall be included to protect the diodes from voltage spikes. Generator shall have the ability to sustain short circuit current of 300% of rated current to allow protective devices to operate.

D. The automatic voltage regulator (AVR) shall maintain generator output voltage within +/- 0.5% for any constant load between no load and full load. The regulator shall be a totally solid state design which includes electronic voltage buildup, volts per Hertz regulation, three phase sensing, over-excitation protection, loss of sensing protection, temperature compensation, shall limit voltage overshoot on startup, and shall be environmentally sealed.

2.4 CIRCUIT BREAKER

A. Provide a generator mounted circuit breaker, molded case or insulated case construction. Breaker shall be sized as shown on the drawings. Breaker shall be Merlin Gerin or equal and utilize a thermal magnetic trip unit and 24 VDC shunt trip. The breaker shall be UL listed with shunt trip device connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box mounted on the side of the generator. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker. Breaker shall include long term, short term instantaneous, and ground fault protection.

2.5 CONTROLS

A. Generator Mounted Control Panel:

1. Provide a generator mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation, adjustable cycle cranking, digital LCD AC metering (0.5% true rms accuracy) with phase selector switch, digital engine monitoring, shutdown sensors and alarms with horn and reset, adjustable cooldown timer and emergency stop push-button. Panel shall incorporate self-diagnostics capabilities and fault logging. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Components shall be housed in a NEMA 1/IP22 enclosure with hinged lid.

2. Provide the following digital readouts on the Generator Mounted Control Panel:

   a. Engine oil pressure

   b. Coolant temperature

   c. Engine RPM

   d. System DC Volts

   e. Engine running hours

   f. Generator AC volts

   g. Generator AC amps

   h. Generator frequency

3. Control Panel Annunciation - Provide the following indications for protection and diagnostics according to NFPA 110 level 1:

   a. Low oil pressure

   b. High water temperature

   c. Low coolant level

   d. Overspeed

   e. Overcrank

   f. Emergency stop depressed

   g. Approaching high coolant temperature

   h. Approaching low oil pressure

   i. Low coolant temperature

   j. Low voltage in battery

   k. Control switch not in auto. position

   l. Low fuel main tank

   m. Battery charger ac failure

   n. High battery voltage

o. Generator supplying load

p. Spare.

4. Generator “Running” , “Common Fault” and “Low Fuel Level” relays with dry, 120VAC, 5 Amp rated contacts.

B. COOLING SYSTEM

1. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110° F ambient air entering the room or enclosure (If an enclosure is specified) without derating the unit and 50/50 anti-freeze mixture. The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

C. FUEL SYSTEM

1. Filter/Separator - In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine.

2. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted.

3. Flexible fuel lines shall be rated for 300 degrees F and 100 PSI.

4. Fuel Tank shall be double wall with Leak Detection.

D. EXHAUST SYSTEM

1. A critical type silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the manufacturer’s recommendation.

2. Mounting shall be provided by the contractor as shown on the drawings. The silencer shall be mounted so that its weight is not supported by the engine.

3. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer.

E. STARTING SYSTEM

1. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.

2. Jacket Water Heater: A unit mounted thermal circulation type water heater. The heater watt rating shall be sized by the manufacturer to maintain jacket

water temperature at 90 degrees F, and shall be a 120 volt, single phase, 60 hertz.

3. Batteries: A lead-acid storage battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The battery set shall be rated no less than 140 ampere hours and 1000 CCA. Necessary cables and clamps shall be provided.

4. A battery tray shall be provided for the batteries and shall conform to NEC 480-7(b). It shall treated to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over battery electrolyte shall be contained within the tray to prevent a direct path to ground.

5. Battery Charger: A current limiting battery charger shall be furnish to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Charger shall have LED annunciation for low DC volts, rectifier failure, loss of AC power, high DC volts. Amperage output shall be as required. Charger shall be wall mounting type in NEMA 1 enclosure, installed in the generator set enclosure.

F. GENERATOR SET ENCLOSURE – SOUND ATTENUATED AND WEATHER PROTECTIVE

1. The complete diesel engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, weather protective enclosure mounted on the fuel tank base.

2. The enclosure shall be constructed of corrosion resistant steel with electrostatically applied powder coated baked polyester paint. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.

3. A dual wall fuel tank base of 24 hour capacity at 100% load shall be provided as an integral part of the enclosure. It shall be contained in a rupture basin with 110% capacity. The tank shall be pressure tested for leaks prior to shipment and have all necessary venting per UL142 standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided.

4. The enclosure shall reduce the ambient noise level at full load to a maximum of 75 dB at 23 feet.

5. Number of doors on enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment

and replacements, hose replacements, access to the control panels, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be reinforced for rigidity.

6. Handles shall be key lockable, all doors keyed alike, and hinges shall be zinc die cast or stainless steel. Fasteners shall be zinc plated or stainless steel. Doors shall be of a lift off design allowing one person to remove door if necessary.

7. Air handling will be sized and designed by the manufacturer for 0.5" static pressure drop through enclosure. Intake openings shall be screened to prevent the entrance of rodents.

8. Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves. Radiator access shall be through a hinged, lockable cover on enclosure. Cooling fan and charging alternator shall be fully guarded to prevent injury.

9. Lifting points shall be provided on base frame suitable for lifting combined weight of base tank, generator set and enclosure.

10. The auxiliary power to the Generator enclosure shall be 208/120V, 3 Phase, 4 Wire. The Generator vendor shall supply and install a 208/120V, 3 phase load center with 100A, 3P main breaker. The load center shall provide power to the Generator enclosure unit heater, exhaust fan, battery charger, block heater, lights, receptacles, and all auxiliary devices required for generator safe and proper operation. The Generator vendor shall prewire all 208V and 120V Generator enclosure loads to the load center. The Generator enclosure shall have a single point 208V connection for all auxiliary power. All electrical components within the Generator enclosure shall be grounded by the Generator vendor for connection to the plant grounding system. See Electrical Drawings for additional details.

G. AUTOMATIC TRANSFER SWITCH

1. GENERAL

a. The transfer switch shall have an enclosure type, voltage and ampacity rating as shown on the Drawings and shall have 600 volt insulation on all parts in accordance with NEMA standards.

b. The current rating shall be a continuous rating when the switch is installed in an unventilated enclosure, and shall conform to NEMA temperature rise standards. Designs which require cabinet ventilation are unacceptable and do not meet this specification.

c. The unit shall be rated based on all classes of loads, i.e., resistive, tungsten, ballast and inductive loads. Switches rated 400 amperes or less shall be UL listed for 100% tungsten lamp load.

d. As a precondition for approval, all transfer switches complete with accessories shall be listed by Underwriters Laboratories, under Standard UL 1008 (automatic transfer switches) and approved for use on emergency systems.

e. The withstand current capacity of the main contacts shall not be less than 20 times the continuous duty rating when coordinated with any molded case circuit breaker established by certified test data.

f. Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.

g. Transfer switches shall comply with the applicable standards of UL, CSA, ANSI, NFPA, IEEE, NEMA and IEC.

h. The transfer switches shall be supplied with a solid state control panel as detailed further in these specifications.

2. SEQUENCE OF OPERATION

a. The ATS shall incorporate adjustable three phase under-voltage sensing of the normal source.

b. When the voltage of any phase of the normal source is reduced to 80% of nominal voltage, for a period of 0-10 seconds (programmable) a pilot contact shall close to initiate starting of the engine generator.

c. The ATS shall incorporate adjustable single phase under-voltage sensing of the emergency source.

d. When the emergency source has reached a voltage value within 10% of nominal voltage and achieved frequency within 5% of the rated value, the load shall be transferred to the emergency source after a programmable time delay.

e. When the normal source has been restored to not less than 90% of rated voltage on all phases, the load shall be re-transferred to the normal source after a time delay of 0 to 30 minutes (programmable). The generator shall run unloaded for 5 minutes (programmable) and then automatically shut down. The generator shall be ready for automatic operation upon the next failure of the normal source.

f. If the engine generator should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of proper voltage (90%) on the normal source.

g. The transfer switch shall be equipped with a solid state control panel. The control panel shall perform the operational and display functions of the transfer switch. The display functions of the control panel shall include ATS position and source availability.

h. The control panel shall include indicators for timing functions, and ATS test switch.

i. The control panel shall be provided with calibrated pots (accessible only by first opening the lockable cabinet door) to set time delays, voltage and frequency sensors. The ATS shall be capable of being adjusted while the controls are energized and the unit in automatic mode. Designs which force a "programming mode" or require the controls be de-energized during adjustment are unacceptable.

j. The control panel shall be opto-isolated from its inputs to reduce susceptibility to electrical noise and provided with the following inherent control functions and capabilities:

   i. An LED display for continuous monitoring of the ATS functions.

   ii. Test switch to simulate a normal source failure.

   iii. Time delay to override momentary normal source failure prior to engine start. Field programmable 0-10 seconds (continuously adjustable via a calibrated potentiometer factory set at 3 seconds.

   iv. Time delay on retransfer to normal source, continuously adjustable 0-30 minutes, factory set at 30 minutes. If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.

   v. Time delay on transfer to emergency, continuously adjustable 0-15 seconds, factory set at 1 second.

   vi. An in-phase monitor or time delayed neutral shall be provided to prevent excessive transient currents from switching motor loads.

   vii. An interval-type automatic clock exerciser with load/no load selectability shall be incorporated in the ATS.

3. CONSTRUCTION AND PERFORMANCE

a. The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.

b. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.

c. For switches installed in systems having ground fault protective devices, and/or wired so as to be designated a separately derived system by the NEC, a 4th pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients. Add-on or accessory poles that are not of identical construction and withstand capability are not acceptable.

d. The contact structure shall consist of a main current carrying contact, which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes above 400 Amps.

e. The transfer switch manufacturer shall submit test data for each size switch required for this project, showing that it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity. Minimum UL listed withstand and close into fault ratings shall be as follows:

i. Any Molded Case Breaker*:

Size (Amps)	(RMS Symmetrical)
Up to 200	10,000
201 - 260	35,000
261 - 400	35,000
401 - 1200	50,000
1201 - 4000	100,000

ii. Specific Coordinated Breaker*:

Size (Amps)	(RMS Symmetrical)
Up to 150	30,000
151 - 260	42,000
261 – 400	50,000
401 - 800	65,000
801 - 1200	85,000
1201 - 4000	100,000

iii. Current Limiting Fuse*:

Size (Amps)	(RMS Symmetrical)
Up to 4000	200,000

*All values 480 volt, RMS symmetrical, less than 20% power factor.

Note: Actual necessary current withstand ratings for this project may be higher than the minimums listed above. Refer to electrical plans for exact requirements.

f. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation between a normal and emergency source that are 120 degrees out of phase at 480 volts, 600% of rated current at .50 power factor. This certification is to ensure that there will be no current flow between the two isolated sources during switching.

g. All relays shall be continuous duty industrial type with wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, relays, timers and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness and keyed disconnect plugs for maintenance.

h. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

i. A manual handle shall be provided for maintenance purposes with the switch de-energized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.

j. The switch shall be mounted in a NEMA 4X stainless steel enclosure unless otherwise indicated on the plans.

k. Switches composed of molded case breakers, contactors or components thereof not specifically designed as an automatic transfer switch will not be acceptable.

l. To afford the advantage of a single source of supply to the owner, the automatic transfer switch shall be supplied by the manufacturer of the engine generator set and covered under the same warranty program.

2.6 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes. Installation of the system includes but is not limited to pouring a concrete pad for the generator set and automatic transfer switch, receiving and offloading the equipment, providing all labor, permits and material to install the total system.

B. Start-Up and Testing

1. Coordinate all start-up and testing activities with the Engineer and Owner.
2. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:
3. Verify that the equipment is installed properly.
4. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote annunciator, etc.
5. Test all alarms and safety shutdown devices for proper operation and annunciation.
6. Check all fluid levels.
7. Start engine and check for exhaust, oil, fuel leaks, vibrations, etc.
8. Verify proper voltage and phase rotation at the transfer switch before connecting to the load.
9. Connect the generator to building load and verify that the generator will start and run all designated loads in the plant.
10. Perform a 4 hour load bank test at full nameplate load using a load bank and cables supplied by the local generator dealer. Observe and record the following data at 15 minute intervals:
    a. Service meter hours
    b. Volts AC - All phases
    c. Amps AC - All phases
    d. Frequency
    e. Power factor or Vars
    f. Jacket water temperature
    g. Oil Pressure
    h. Fuel pressure
    i. Ambient temperature

11. Operation and Maintenance Manuals
    a. Provide three (3) sets of operation and maintenance manuals covering the generator, switchgear, and auxiliary components. Include parts manuals, final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

2.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

1. Train Owner’s maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.

2. Review data in maintenance manuals. Refer to Division 1 Section “Operation and Maintenance Data”.

3. Schedule training with Owner, with at least seven days’ advance notice.

4. Minimum Instruction Period: Four hours.

END OF SECTION

SECTION 16440
DISCONNECT SWITCHES
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SECTION 16440
DISCONNECT SWITCHES

PART 1. GENERAL

1.1 SCOPE

A. Work includes furnishing labor, materials, and equipment, tools and incidentals for complete and operable disconnect switches.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

C. This Section includes individually mounted switches used for the following:
   1. Feeder and equipment disconnect switches.
   2. Feeder branch-circuit protection.
   3. Motor rated disconnect switches.
   4. Motor rated starting switches.

D. Related Sections include but are not limited to:
   1. Section 16000 – Electrical Power and Systems.

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. InterNational Electrical Testing Association (NETA).
      a. NETA ATS – Acceptance Testing Specifications for Electrical Power distribution.
   2. Underwriters Laboratories Inc. (UL).
      a. UL 486A – Wire Connectors.
      b. UL 508 – Industrial Control Equipment.
   3. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.
   4. National Electrical Code (NEC).
      a. NEC Article 10 – Administrative Section.
   5. National Electrical Manufacturers Association (NEMA).
   6. Occupational Safety and Health Administration (OSHA).

1.3 SUBMITTALS

A. General: Submit each item in this Section according to Section 01300 – Submittals.

B. Product Data for disconnect switches and accessories specified in this Section.

C. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.

E. Field test reports indicating and interpreting test results.

F. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Section 01700 – Contract Closeout.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Section 01400 - Quality Control, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the InterNational Electrical Testing Association (NETA).
   1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in engineering Technologies, to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain disconnect switches from one source and by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: provide disconnect switches specified in this Section that are UL listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

E. See also Section 16010 – General Electrical Requirements, Part 1 for listing of applicable reference standards.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering disconnect switches that may be incorporated into the Work include, but are not limited to, the following: Eaton, ABB / GE, Siemens, or Schneider Electric, or accepted equal.

B. Motor rated starting switches shall be as manufactured by Eaton, ABB / GE, Siemens, or Schneider Electric, or accepted equal.

2.2 DISCONNECT SWITCHES

A. Enclosed, Non-fusible Switch: 600 volt, heavy duty, single throw safety switch, with lockable handle. Quantity of poles and ampere rating shall be as required to meet the application. Also, switches for motor applications shall be horsepower rated to meet or exceed the connected motor load. Square D Class 3110, or accepted equal.

B. Enclosed, Fusible Switch: 600 volt, heavy duty, and single throw safety switch with lockable handle and with clips to accommodate specified fuses. Fuse size shall be per Contract Drawings and/or to match protected equipment manufacturers recommendation. Quantity of poles and ampere rating shall be as required to meet the application. Also, switches for motor applications shall be horsepower rated to meet or exceed the connected motor load. Square D Class 3110, or accepted equal.

C. Enclosure: As specified or required to meet environmental conditions of installed location:
   1. Dry Indoor Locations: NEMA 1
   2. Outdoor Locations: NEMA 4 stainless steel, unless noted otherwise.
   3. Wet or Damp Indoor Locations: Stainless Steel NEMA 4.
   4. Below Grade Locations: Stainless Steel NEMA 4
   5. NEC Class 1 Hazardous Locations: NEMA 7 with applicable Group (A, B, C, D) rating.
   6. Chemical or Corrosive Locations: NEMA 4X Stainless Steel.

D. Switches shall have handles lockable with two padlocks and shall have a dual cover interlock.

E. Disconnect switches used on single phase, three wire or three phase, four wire applications shall have a factory installed neutral assembly.

2.3 MOTOR RATED STARTING SWITCHES

A. Motor rated starting switches shall conform to UL 508.

B. Motor rated starting switches shall only be used on single pole fractional horsepower motors.

C. Motor rated starting switches shall have thermal overload protection sized per the motor nameplate.

D. Enclosure shall be compatible with the environment where located.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install switches in locations as follows.
   1. Where shown on the Contract Drawings.
   2. Where required by the NEC or other governing Code.
   3. Where required by local authority having jurisdiction.
   4. Where required by manufacturer of equipment.

B. Install switches level and plumb and accessible.

C. Connect disconnect switches and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Identify each disconnect switch according to requirements specified in Section 16195 - Electrical Identification.

E. Install such that clear working space per NEC Art 110 provided at the disconnect switch.

F. Conduit terminations at disconnect switches shall be compatible with the NEMA rating of the enclosure. NEMA 4 enclosures shall use watertight hubs.

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

SECTION 16461
LOW VOLTAGE DRY TYPE TRANSFORMERS
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SECTION 16461
LOW VOLTAGE DRY TYPE TRANSFORMERS

PART 1. GENERAL

1.1 SCOPE

A. This Section includes general-purpose and specialty dry type transformers and voltage regulators with windings rated 600 V or less.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

C. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 01400 – Quality Control.
   3. Section 16010 – General Electrical Requirements.
   4. Section 16060 – Grounding and Bonding.
   5. Section 16195 – Electrical Identification.

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. National Electrical Manufacturers Association (NEMA).
      a. NEMA ST-1 – Specialty Transformers (Except General Purpose Type).
   2. Underwriters Laboratories Inc. (UL).
      a. UL 486A and 486B – Wire Connectors.
      b. UL 506 – Standard for Specialty Transformers.
   3. American Society for Testing and Materials (ASTM).
      a. ASTM E699 – Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
   4. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.
   5. Institute of Electrical and Electronic Engineers (IEEE).
      a. IEEE C57.12.91 – Standard Test Code for Dry-Type Distribution and Power Transformers.
   6. National Electrical Code (NEC).
      a. NEC Art 100 - Definitions

1.3 SUBMITTALS

A. General: Submit the following according to Section 01300 – Submittals.

B. Product data for each product specified, including dimensioned plans, sections, and elevations. Show minimum clearances and installed features and devices.

C. Wiring diagrams of products differentiating between manufacturer-installed and field-installed wiring.

D. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include a list of relevant completed projects with project names and addresses, and points of contacts with telephone numbers.

F. Operation and maintenance data for materials and products to include in Section 01700 – Contract Closeout.

G. Field test reports of tests and inspections conducted according to Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: experienced in manufacturing components that comply with the requirements of these Specifications and that have a record of successful in-service performance.

B. Field-Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.

C. Comply with NFPA 70 "National Electrical Code."

D. Listing and Labeling: Products shall be UL listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

E. See also Spec 16010 – General Electrical Requirements, Part 1 for listing of applicable reference standards.

1.5 DELIVERY, STORAGE, AND HANDLING.

A. Temporary Heating: Apply temporary heat according to manufacturer's recommendations within the enclosure of each ventilated type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer shall be ABB, ACME, Eaton, Siemens, Schneider Electric or accepted equal.

2.2 TRANSFORMERS, GENERAL

A. Transformers: Factory-assembled and tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous copper windings without splices except for taps.

D. Internal Coil Connections: Brazed or pressure.

E. Insulation Class: 185°C temperature class with 115°C temperature rise for transformers 25 kVA or smaller. 220°C temperature class with 150°C temperature rise for larger than 25 KVA.

F. Taps: For transformers 15 KVA through 300 KVA, full capacity taps in high-voltage winding are as follows: Six 2.5% taps, 2 above and 4 below rated high voltage.

G. Transformers intended for installation outdoors shall have manufacturer supplied weather shields.

H. Transformers intended for installation in chemical or corrosive areas shall have stainless steel enclosed resin encapsulated core and coil. Such transformers shall be manufacturer certified as suitable for harsh and corrosive environments.

I. Transformers shall have floor and wall mounting brackets as required for secure fastening.

J. Unless noted otherwise, transformers furnished shall be high efficiency transformers meeting DOE standards.

2.3 CONTROL AND SIGNAL TRANSFORMERS

A. Comply with NEMA Standard ST 1, “Specialty Transformers,” and UL Standard 506, “Specialty Transformers.”

B. Ratings: Continuous duty. Where ratings is not indicated, provide capacity exceeding peak load by 50% minimum.

C. Type: Self-cooled, 2-winding, dry type.

D. Enclosure: Suitable for the location where installed.

2.4 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. Outdoor Units: Manufacturer's premium paint over corrosion resistant pretreatment and primer.

2.5 SOURCE QUALITY CONTROL

A. Factory tests: Design and routing tests conform to referenced standards.

PART 3. EXECUTION

3.1 INSTALLATION

A. Arrange equipment to provide adequate spacing for access and for cooling air circulation.

B. Identify transformers and install warning signs according to Section 16195 - Electrical Identification.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified in UL 486A and UL 486B.

D. If installed on the floor or grade, the contractor shall include 4" high concrete housekeeping pad.

3.2 GROUNDING

A. Ground transformers and systems served by transformers according to Section 16060 - Grounding and Bonding.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Provide services of and independent electrical testing agency according to the requirements of Division 1 Section 01400 - Quality Control, to perform tests on installations made under this Section.

B. Test Objectives: To ensure transformer installation is operational within industry and manufacturer's tolerance, install according to Contract Documents, and suitable for energizing.

C. Test Labeling: Upon satisfactory completion of tests for each unit, attach a dated and signed "Satisfactory Test" label to the tested component.

D. Schedule tests and provide notification at least one week in advance of test commencement.

E. Report: Submit a written report of observations and tests. Report defective materials and workmanship.

F. Tests: Include the following minimum inspections and tests according to the manufacturer's instructions. Conform to IEEE Standard Test Code C57.12.91 for dry-type units, test method, and data correction factors.

1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.

a. Include internal inspection through access panels and covers.

b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values, or where not available, those of UL standards 486A and 486B.

2. Insulation Resistance: Perform megohmmeter test of primary and secondary winding-to-winding and winding-to-ground. Use a minimum test voltage of 1,000 V d.c. Minimum insulation resistance is 500 megohms.

3. Duration of Each Test: 10 minutes.

4. Temperature Correction: Correct results for test temperature deviation from 20°C standard.

G. Test Failures: Correct Deficiencies identified by tests and retest. Verify that equipment meets the specified requirements.

3.4 ADJUSTING

A. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating facility. Record voltages and tap settings to submit with test results.

END OF SECTION

SECTION 16470
PANELBOARDS
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SECTION 16470
PANELBOARDS

PART 1 GENERAL

1.1 SCOPE

Panelboards.

1.2 SUBMITTALS

Submit shop drawings.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Equipment shall be manufactured by General Electric/ABB, Siemens, Square D, Eaton, or equal.

2.2 PANELBOARDS

A. Panelboards: NEMA PB-1; UL 67.

B. Rating: Voltage and ampere ratings are shown on the Drawings. Unless otherwise indicated interrupting ratings (RMS symmetrical) are 14,000 amps for 480-volt panelboards and 10,000 amps for 240 and 208 volt panelboards.

C. Boxes: Code gauge galvanized steel; sized to accommodate devices indicated and afford wire bending space in accordance with NEC requirements.

D. Fronts: Surface or flush as indicated, door-in-door construction, finished in light grey enamel over a rust inhibitor. Furnish flush lock for fronts less than 48-inches high and vault type handle with three point catch for fronts 48-inches and higher. Key all locks alike.

E. Bus: Copper, arranged for bolt-on circuit breakers. Furnish insulated neutral bus and ground bus with main lug bonded to the box.

F. Circuit Breakers: NEMA AB-1; molded case type, thermal-magnetic trip with internal common trip on multipole breakers. Provide breaker fully rated for interrupting ratings noted; series ratings are not acceptable.

G. Where fusible switch type panelboards are indicated provide panel fronts without doors and individual doors for switch units. Switches: NEMA KS-1; quick-

make, quick-break, load interrupter type, horsepower and i^2t rated, and equipped with Class J rejection fuse clips.

H. Provide engraved nameplates giving the voltage rating and panel designation as indicated. Provide a UL service entrance label for panelboards used as service entrance equipment.

I. Two Section Panels: Box and from same height each section.

J. Surge Protection: Where indicated, provide transient voltage surge suppressors equal to Advanced Protection Technologies TE Thousand Series (main and distribution panels) and TE Hundred Series (branch circuit panels). Mount in the panel gutter unless space does not permit, or panel UL label is voided - in which case furnish loose for installation by the Contractor adjacent (less than five feet) to the panel. Connect to load side of main breaker and do not fuse.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install boxes so they are rigidly supported and correctly aligned. Select mounting height so that operating handles are not higher than 6 feet 6-inches nor lower than 24-inches above the floor.

B. For flush mounted panels provide a ¾-inch empty raceway for each three unused spaces and spare poles. Terminate in a junction box located above the ceiling or other approved accessible location for future extension.

C. Prior to energizing panelboards clean out construction dirt and debris. Paint any scratches on trims or dead front barriers. Meggar each phase to phase ground to ensure that no short circuits exist.

D. Adjust panel barriers so that no opening occur between them and the panel front. Provide filler plates and plugs as necessary to maintain dead front integrity.

E. Type directory cards with circuit loads and/or area served. Note spare circuits in pencil.

3.2. FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 16473
LOW VOLTAGE SURGE PROTECTION DEVICES
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SECTION 16473
LOW VOLTAGE SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing labor, materials, and equipment, tools, and incidentals for complete and operable surge protective devices for electrical power panels, motor control centers, and switchboards.

B. Provide a surge protective device for each Service Entrance and Main Distribution panelboard/switchboard. Other Branch panelboards, switchboards, and motor control centers shall have a surge protective device only when called for on the Contract Drawings.

C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

D. Related Sections include but are not limited to:
   1. Section 16010 – General Electrical Requirements.
   2. Section 16060 – Grounding and Bonding.
   3. Section 16120 – Wire and Cable (600V).
   4. Section 16470 – Panelboards.
   5. Section 16481 – Low Voltage Motor Control Centers.

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. Institute of Electrical and electronics Engineers (IEEE).
      a. IEEE C62.41 – IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits.
      b. IEEE C62.45 – IEEE Guide for Surge Suppressor Testing.
   2. National Electrical Code (NEC).
      a. NEC Article 285 – Transient Voltage Surge Suppressors.
   3. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.
   4. National Electrical Manufacturers Association (NEMA).
      a. NEMA LS-1 – Low Voltage Surge Protective Devices.
   5. Underwriters Laboratories Inc. (UL).
      a. UL 1283 – Electromagnetic Interference Filters.
      b. UL 1449 – Transient Voltage Surge Suppressors.

6. Occupational Safety and Health Administration (OSHA).
    a. OSHA – Definitions and Requirements for a Nationally Recognized Testing Laboratory.

1.3 SUBMITTALS

A. Shop drawings, product data, and manufacturer's installation instructions, and shall be submitted for review ten days prior to the bid date for all non-approved manufacturers. Submittals shall be in accordance with the Conditions of Section 01300 - Submittals.

B. The submittals shall include:
    1. Dimensional drawing of each suppressor type.
    2. UL Standard 1449 Listing, Standard for Safety, *Transient Voltage Surge Suppressors,* documentation.
    3. UL Standard 1283 Listing, *Electromagnetic Interference Filters,* documentation.
    4. IEEE C62.41 Category C3 (20kV-1.2/50, 10kA-8/20μs waveform) let through voltage test results.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" Article 285 for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
    1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
    2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Comply with NECA "Standard of Installation."

D. Comply with UL 1449 latest edition IEEE C62.41, UL standard for safety for transient voltage surge suppressors.

E. Comply with NEMA LS1 Low Voltage Surge Protective Devices.

F. Test per IEEE C62.45, 8 x 20 microsecond current wave test.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering Products that may be incorporated in the Work:
    1. Square D (SurgeLogic by Schneider Electric).

2. Advanced Protection Technologies.
3. Eaton/Cutler-Hammer.
4. Innovative Technology.
5. Total Protection Solutions.
6. ABB / GE
7. Phoenix Contact
8. Or approved equal.

2.2 DESIGN

A. The unit shall consist of metal oxide varistors (MOV's) connected together such that all components shall share surge currents in a seamless, low stress manner. All internal components shall be hardwired utilizing low impedance connections.

B. The unit shall include a high performance EMI/RFI noise rejection filter. The noise attenuation shall be no less than 45 dB at 100 KHz.

C. The unit shall have internal fusing, rated at 200 KiloAmperes interrupting capacity for each suppression element. Where indicated, provide integrally mounted disconnect switch.

D. The unit shall have phase failure indication light emitting diode indicators on the front of the enclosure door. Dry contacts, 10 Amperes at 120 Volts, for remote alarm.

E. Enclosure shall be a rated enclosure suited for the environment. Reference section on enclosure ratings.

2.3 ELECTRICAL REQUIREMENTS

A. The operating voltage shall be as shown on Contract Drawings.

B. Maximum continuous operating voltage shall be greater than 115% of the nominal operating voltage.

C. The unit shall have either a Delta or Wye configured projection mode.
   1. Wye: direct connected suppression elements between the line to neutral, line to ground and neutral to ground conductors.
   2. Delta: direct connected suppression elements between the line to line and the line to ground conductors.

D. Provide units with rated surge current capacity as follows for the types of switchboards/motor control centers/panelboards shown. For purposes of this section, "Service Entrance" is defined as a switchboard or panelboard which receives its supply from a utility service, utility transformer, or substation transformer; "Main Distribution" is defined as a non-utility powered switchboard or panelboard which has multiple branch feeder circuits of 100 amperes or larger; "Branch" is defined as any other switchboard or panelboard.

1. "Service Entrance" Switchboard or Panelboard; SPD (surge arrester) located on the line side of service disconnect: Type 1 SPD (per UL 1449).
2. "Service Entrance" Switchboard or Panelboard; SPD (transient voltage surge suppressor) located on the load side of service disconnect: Type 2 SPD (per UL1449).
3. "Main Distribution" Switchboard or "Main Distribution" Panelboard or Motor Control Center; SPD (transient voltage surge suppressor) located on load side of main overcurrent device: Type 2 SPD (per UL 1449).
4. "Branch" Switchboard or Panelboard: Type 2 SPD (per UL 1449) in switchboard or panelboard.

E. KiloAmpere Phase and Mode ratings shall meet or exceed the following standards:
1. Type 1 SPD: 240 KiloAmperes per phase, 120 KiloAmperes per mode.
2. Type 2 SPD: 160 KiloAmperes per phase, 80 KiloAmperes per mode.

F. The surge rating per UL 1449, shall not exceed:
1. Wye: 400 Volts @ 120/208 Volts 800 Volts @ 277/480Volts
2. Delta: 800 Volts @ 120/208 Volts 1500 Volts @ 277/480 Volts

G. The maximum let through voltage shall not exceed:
1. 120/208 Volts: 170/500 ANSI/IEEE Category B3/C3
2. 277/480 Volts: 300/900 ANSI/IEEE Category B3/C3

H. Provide a five (5) year replacement warranty for all materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment for compliance with contract documents and other conditions affecting performance of the transient voltage surge suppression system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer written instructions.

B. Install as close as physically possible to panel for maximum protection and optimum performance.

3.3 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

3.4 CLEANING

B. Upon completion of installation of system, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END SECTION

SECTION 16484

CONTACTORS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing labor, materials, and equipment, tools, and incidentals for complete and operable contactors.

B. Work in this Section includes:
   1. Lighting contactors.
   2. Enclosures.

C. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 16010 – General Electrical Requirements.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. National Electrical Manufacturers Association (NEMA).
      a. NEMA ICS-2 – Standard for Industrial Control Devices, Controllers and Assemblies.
      b. NEMA ICS-6 – Industrial Control and System Enclosures.

1.03 SUBMITTALS

A. Submit product data. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. General Electric.

B. Square D.

C. Westinghouse.

D. Siemens

E. Or accepted equal.

2.02 LIGHTING CONTACTORS

A. Contactors: NEMA ICS-2; mechanically held, unless otherwise indicated.

B. Coil Operating Voltage: 120 volts, 60 Hertz.

C. Contacts: as indicated.

D. Enclosure: NEMA ICS-6; Type 1.

E. Controls:
   1. 480-volt contactors to include 480-120 volt control power transformer with HOA switch and red indicating light mounted on contactor door in MCC.
   2. 120-volt contactors to be furnished with HOA switch and red indicating light mounted on contactor enclosure door.

F. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION 16484

SECTION 16489
LOW VOLTAGE VARIABLE FREQUENCY DRIVES
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SECTION 16489
LOW VOLTAGE VARIABLE FREQUENCY DRIVES

PART 1 -

1.1 SCOPE

A. The Contractor shall furnish and install complete and operable low voltage variable frequency drives (VFDs), by-pass motor starters, and isolation phase shifting transformers as described in this specification and as detailed on the applicable drawings.

B. Work included in this Section.

1. Variable Frequency Drives (VFDs)
2. By-Pass Motor Starters
3. Isolation / phase shifting transformers

C. Related Sections include but are not limited to:

1. Section 16010 – General Electrical Requirements.
2. Section 16060 – Grounding and Bonding.
3. Section 16150 – Low Voltage Induction Motors.
4. Section 16473 – Low Voltage Surge Protection Devices.
5. Section 16481 – Low Voltage Motor Control Centers.

D. The Contractor shall be responsible for the installation, and start-up of the equipment covered by this specification.

E. The Contractor shall be responsible for coordinating the drive requirements with the manufacturer of the load which the AFD shall operate in order to ensure that the correct type of drive (i.e. constant torque or variable torque) is provided for each application. In order to ensure that the Contactor has properly coordinated the specific type of drive to be provided for each particular process, the submittals for all adjustable frequency drives shall include a letter from the manufacturer of the specific load that will be energized from the AFD to indicate if the specific application requires a constant torque drive or a variable torque drive.

F. The Contractor shall be responsible for coordinating with the AFD manufacturer on the actual feeder distances required in order to ensure that the appropriate type of output filters, or dv/dt filters, are provided, where required. In order to ensure that the Contactor has properly coordinated with the AFD manufacturer, all submittals for AFDs shall include a letter from the AFD manufacturer that indicates that they have coordinated with the Contractor on the actual feeder lengths required and that the appropriate type of output filters, or dv/dt filters, are provided as proposed within the submittal.

G. Complete drawings shall be furnished for approval and shall consist of master wiring diagrams, elementary or control schematics, including coordination with

other electrical control devices operating in conjunction with each VFD. Suitable outline drawings showing details necessary to locate conduit stub ups and field wiring shall be furnished for approval before proceeding with manufacturer.

H. The VFDs shall be UL certified and shall comply with the latest applicable standards of ANSI, IEEE and NEMA. The VFDs shall be rated as shown on the Drawings. As a minimum the full load output current of the controller shall be equal to the equivalent motor horsepower as listed by National Electrical Code Table 430-150.

I. The manufacturer shall furnish to the Engineer a factory test report for each VFD. Refer to Part 3 - Execution, of this section.

J. Line voltage notching limits shall be as specified in Table 1 below during normal operation. The points of voltage measurement shall be at the main switchboard.

Table 1

Class	Notch Depth	A_N	DF_{VN}
General System	20%	22,800	5%

Notch Depth = Z1/ (Z1 + Z2) where Z2 is the impedance between the converter and point of common-coupling (PCC) and Z1 is the short circuit impedance at PCC. This is equivalent to 1/p.

DF_{VN} = Voltage distortion factor from notching

A_N = Notch Area (Voltmicroseconds)

K. Electromagnetic Interference Limitations.

1. EMI (electromagnetic interference) and FRI (Radio frequency interference) created by the specified VFDs shall be limited as far as possible to allow proper operation of all project equipment as well as to prevent interference with any equipment utilized beyond the boundaries of the treatment plant.

2. EMI and RFI produced by the specified VFDs shall be limited by all means possible including filters to limits defined in Federal Communications Commission (FCC) Rules and Regulations Volume 2, Part 15, Subpart J, Class A.

L. Powerline disturbances shall be limited per requirements of IEEE Standard 519 latest edition including harmonic currents at the high voltage side of utility transformers (point of common coupling - PCC) and Harmonic Voltage distortion at PCC. Point of analysis (POA) shall be the service entrance MCC.

M. Contractor shall evaluate all system components, and provide calculations showing dominant harmonics and line notching depths. Contractor shall provide necessary

isolation transformers, and other necessary components to comply with IEEE-519, latest edition.

N. All VFDs shall be pulse width modulated Active Front End (AFE) type for motors 50 HP and larger. VFD drives for motors less than 50 HP can be of the 6-pulse type, subject to compliance with IEEE-519 recommended interference limitations.

O. VFD manufacturers/suppliers shall coordinate the application of the VFDs with the driven mechanical equipment and motors manufacturer/supplier. However, requirement is that the driven equipment manufacturers supply the VFDs in accordance with this Section.

P. Based on specific application(s), drive manufacturer shall provide output line reactors, as required.

Q. To the extent possible, VFDs rated for control of motors 150 HP and less shall be located in a motor control center. See Section 16481 – Low Voltage Motor Control Centers.

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.

1. American National Standards Institute (ANSI).
   a. ANSI 61 – Drinking Water system Components.

2. Underwriters Laboratories Inc. (UL).

3. Institute of Electrical and Electronics Engineers (IEEE).
   a. IEEE 519 – Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

4. National Electrical Manufacturers Association (NEMA).

5. Federal Communications Commission (FCC).
   a. FCC – Rules and Regulations Volume 2.

6. National Electrical Code (NEC).
   a. NEC Table 430-150 – Full Load Current – Three Phase AC Motors.

7. Department of Defense (DOD).
   a. DOD MIL-I-45208 – Inspection Systems Requirements.

8. Military Specification (MIL).
   a. MIL-STD-C45662 – Calibration Systems Requirements.
   b. MIL-STD-45208 – Inspection.
   c. MIL-STD-105D – Sampling Plan.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01300 – Submittals.

B. Materials List. The materials list shall be complete and include all products in this section, including the equipment that shall have shop drawings. The list shall include only one manufacturer for each type of product.

C. Shop Drawings. The shop drawings for the automatic variable frequency drive equipment shall be complete and shall include the following:

1. Plans showing the floor space requirements, clearance, conduit, and anchor bolt locations.

2. Details showing the required enlarged views of small parts.

3. Diagrams showing the equipment, equipment locations, wiring circuits schematics, voltage, wire numbers, and identified terminals.

4. Connection and schematic wiring diagrams for each equipment showing numbered terminal points and wires and interconnections to other units and/or remote devices.

5. A complete bill of materials and complete catalog information of all components contained in the equipment including manufacturer's name and model numbers.

6. Panel layouts including elevation of front, elevation of front with cover open, and nameplate inscriptions. Layout drawings shall be of sufficient size to determine adequacy of equipment.

7. Dimensions of the equipment.

8. Weights of the equipment.

9. Nameplate data including the nameplate material, height of letters, number of lines, inscriptions, and dimensions.

D. Technical Data. Submit complete system and equipment description including detailed draft theory of operation and operation data to the Engineer with shop drawings. To be included in the final version in the Operation and Maintenance Manuals.

E. Parts Lists. Submit to Engineer with the shop drawings a complete, priced list of parts that would be necessary to maintain and service the equipment.

F. Factory Test Reports. Submit manufacturer's certified factory test reports to the Engineer.

G. Manufacturer's Certified Reports. Submit a notarized written report from the equipment manufacturer with respect to his equipment certifying that (1) the

equipment has been properly installed, wired, and connected under his supervision, (2) the equipment is in accurate alignment, (3) he was present when the equipment was placed in operation, (4) he has checked, inspected, and adjusted the equipment as necessary, (5) the equipment has been operated satisfactorily under all system conditions and (6) the equipment is fully covered under the terms of the guarantee. The manufacturer shall also furnish a certified report indicating compliance with Paragraph 1.01E, F, and G.

H. Furnish (10) Operation and Maintenance Manuals in accordance with Section 01700 – Contract Closeout.

1.4 QUALITY ASSURANCE

A. VFD supplier shall have responsibility for the compatibility of the variable frequency drives, motors and isolation / phase shifting transformers (as applicable). The VFD supplier must confirm that his equipment is completely compatible with the pump or fan driven equipment and motors and with the electrical power system at each location. The VFD supplier shall coordinate with the mechanical equipment supplier to determine whether constant torque, variable torque, or other type is the most satisfactory application.

B. The manufacturer of the VFD shall have a permanent fully factory authorized and trained, service agent employed with a technical staff and an equipped service facility within a 100 mile radius of the project site, having all personnel and all equipment required to maintain, repair, or overhaul the VFD and associated systems supplied herein.

C. The manufacturer of the VFD system shall use components and subsystems (i.e., circuit breakers, relays, control transformers, etc.) conforming to this specification as listed elsewhere.

1.5 INDIVIDUAL EQUIPMENT REQUIREMENTS

A. Verification. Verify that the variable frequency drive equipment output speed, horsepower and torque range are adequate and compatible with the motor and driven equipment requirements.

B. Motors. All Motors run by the VFDs shall be Inverter Duty rated.

C. Wiring. Wiring for variable speed equipment shall comply with requirements shown on the Drawings.

D. Instrumentation Equipment. Instrumentation equipment provided and/or required under this Section shall comply with requirements specified herein and Sections of Division 13.

E. Codes and Standards. Equipment, materials and installation shall conform to the codes and standards that are listed in Section 16010 - General Electrical Requirements, and IEEE 519, latest version. The Variable Frequency Drive shall be UL listed.

1.6 OVERALL SYSTEM REQUIREMENTS

A. In addition to operating adequately and properly as individual equipment, the drives must operate together as a system such that they do not affect each other or other systems (including the power service company electrical system, programmable logic controllers, control panels, radio and electronics devices, etc.) adversely. To this end the harmonic voltage and current distortions, and line voltage notching, produced by the variable frequency drives at the point of common coupling (PCC) which will be the point of analysis (POA), shall be limited per requirements of IEEE Standard 519 latest edition.

1.7 WARRANTY

A. With respect to equipment, guarantee shall cover (1) faulty or inadequate design; (2) improper assembly or erection; (3) defective workmanship or materials; and (4) incorrect or inadequate operation, or other failure. For equipment bearing a manufacturer's warranty in excess of 1 year, furnish a copy of the warranty to the Engineer with Owner named as beneficiary.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. When mounted in the MCC, the VFDs shall be furnished by MCC manufacturer.

B. For standalone VFD shall be furnished by manufacturer who has actively been manufacturing variable frequency drives for a period of at least five (5) years. The VFDs shall be by Allen-Bradley, ABB / GE, Schneider Electric, Eaton, Danfoss, or approved equal.

2.2 CONSTRUCTION and characteristics

A. Each low voltage VFD shall provide constant volts per hertz excitation for its respective motor up to 60 Hertz.

B. The VFDs shall have a 110% current rating for one minute.

C. The VFDs shall be capable of converting incoming three phase, 480 V (+10% to -10%), 60 hertz (±2 hertz) power to a fixed potential dc bus level. The dc voltage shall be inverted to an adjustable frequency output. The controller shall maintain displacement power factor at 95% or greater at any speed or load. The VFDs shall have a minimum efficiency of 96% at rated load.

D. The VFDs shall operate in an ambient temperature of 0^{o}C to 40^{o}C, and humidity of 0 to 95%.

E. Each VFD enclosure shall be NEMA 1A gasketed unless otherwise indicated on the Drawings, and the VFDs shall be MCC mounted or floor mounted (stand-alone) as defined herein and/or shown on the Contract Drawings.

F. All enclosures shall be not less than 16-gauge steel with surfaces thoroughly cleaned and phosphatized prior to painting. They shall be primed with a corrosion-resisting coating. Cabinet finish paint to be ANSI 61 Gray. Provide barriers as required to prevent entrance of vermin and rodents.

G. The operating handle of the disconnect shall always remain connected to the disconnect and shall not be mounted on the door. The position handle shall indicate On or Off. The handle shall have provisions for padlocking in the off position with at least three padlocks. Interlock provisions shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the on position.

H. The following standard basic control features shall be provided on each VFD:

1. Terminations for all required door and/or remote mounted devices.
2. Linear independent time acceleration and deceleration adjustments.
3. Output frequency range of 4-60 hertz, factory set.
4. Frequency stability of 0.5% for 24 hours with voltage regulation of ±2% of maximum rated output voltage.
5. Control power transformer, 480-120 volt for operator devices.
6. All terminals necessary for customer permissive contacts and required interlocking as required by the drawings.
7. Fully digital regulator with microprocessor control of frequency, voltage, and current.
8. The drive shall be designed to protect itself against instantaneous current levels above 150% of its rating.
9. The drive shall not be sensitive to line notching from other drives.
10. The drive shall be capable of riding through a momentary power outage of 5 cycles without causing the drive to shut down.
11. The drive shall actively monitor its output current and frequency and if the motor is in a stall condition the drive will shut down. A stall condition is defined as operating in current limit at or below 10 Hertz for 10 seconds. This definition of stall shall be field adjustable to match the applications.
12. The minimum acceptable efficiency shall be 96% at full load.
13. The deceleration rate shall be constant and independent of motor speed.
14. The inrush current shall be limited to 150% of the full load current.

I. The following independent adjustments shall be provided on each VFD:

1. Minimum speed - 4 to 40 hertz.
2. Maximum speed - 40 to 90 hertz (factory set for 60 hertz).
3. Acceleration - 5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
4. Deceleration - 5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
5. Low frequency boost - up to 60 Volts at 4 hertz.
6. Volts per hertz - Adjustable from 3.83 to 11.5 volts per hertz.
7. Stability.
8. Output signal of 4-20 ma dc, proportional to VFD output frequency including gain and bias adjustments.

9. Controller status relay with two Form C relay pairs, rated 2 amps resistive at 115 Volt ac for indication of running condition.
10. Laminated plastic nameplate engraved with customer's identifying name or number of each VFD.

J. The following features shall be furnished with each VFD:

1. Full time adjustable current limit shall sense an overload on the motor when current exceeds a preset limit. Output frequency and therefore motor speed shall be reduced. If current decreases with speed, the speed shall decrease until current drops below the limit. Once current is reduced to normal, the frequency shall return to the original setting.

2. AC output contactor and interposing control logic.

3. Motor overcurrent relay, wired to stop unit upon trip, manually reset.

4. Isolated signal follower for use with grounded input signal (4-20 madc) for control of VFD output frequency.

5. Output load ammeter, voltmeter and speed indicating meters.

6. Door-mounted NEMA 1A gasketed or as indicated operator controls with heavy duty industrial rated devices as shown on drawings.

7. "Hand-Off-Remote" reference selector switch to enable operator to select the speed control means from the plant control system computer (remote) or from the drive (hand).

8. Digital display for monitoring the following functions:
   a. Drive output frequency.
   b. Motor Load calibrated in amps.
   c. Drive output power in Kw.
   d. Drive output voltage in volts.
   e. Over current.
   f. Under voltage
   g. Over voltage.
   h. Fault diagnostic messages (system, board, component level).

K. The following protective features shall be provided on each VFD:

1. Suitability for use on an electrical system with fault current as shown on the drawings.

2. Input ac circuit breaker or fused switch disconnect with an interlocked, padlockable handle mechanism.

3. AC input line current limiting fuses for fault current protection of ac to dc converter section, if required to meet short circuit requirements.

4. Electronic overcurrent trip for instantaneous overload protection.

5. AC input line undervoltage and phase loss protection.

6. Over frequency protection.

7. Over temperature protection.

8. Over voltage protection.

9. Low logic supply protection.

10. Electrical isolation between the power and logic circuits, as well as between the 115 Volt ac control power and the static digital sequencing.

11. Ability to withstand output terminal line-to-line short circuits without component failure.

12. Supply voltage phase loss.

13. For any protective condition, the VFD shall trip and an internal fault relay contact shall close for remote indication.

L. RFI and EMI. RFI filters as required. The adjustable frequency drive system shall contain all necessary filters and devices, and be constructed and installed in manner, to eliminate significant levels of conducted and radiated electrical noise. The EMI and RFI emissions from the variable frequency drive system shall not exceed the levels specified in FCC Rules and Regulations, Volume 2, Part 15, Subpart J, Class A. If after installation, any interference or noise occurs, the supplier shall take corrective action by installing whatever additional equipment or corrective measures that may be required, at no additional cost to the Owner.

M. Replaceable Parts. One each of each replaceable part such as printed circuit boards, plug-in modules, module assemblies, etc., and three each of each type of diode, IGBT, SCR or transistor, fuse, light, etc., not mounted on a provided assembly shall be supplied in the manufacturer's original cartons, clearly marked by name and part number as referenced in the maintenance manual. A list of such parts with prices shall be submitted with the shop drawings. The above shall exclude such items as power transformers, chokes, contactors, etc., which shall have a mean time between failures (MTBF) of 100,000 hours minimum.

N. The drive shall have surge and lightning protection using transient voltage surge suppressors, or approved equal. See section 16473 – Low Voltage Surge Protection Devices, for details.

O. Parameter Settings

1. The following system configuring settings, shall be provided, without exception, field adjustable through the keypad/display unit or via the serial communication port only.

a. Motor Nameplate Data:
   i. Motor frequency.
   ii. Number of poles.
   iii. Full load speed.
   iv. Motor volts.
   v. Motor full load amps.
   vi. Motor KW.
   vii. Current limit, min.
   viii. Current limit, max.

b. VFD Limits:
   i. Independent accel/decel rates.
   ii. Motor flux build-up delay: time/amount.
   iii. Vmin, Vmax, V/Hz.
   iv. I boost.
   v. Overload trip curve select (inverse or constant).
   vi. Min/Max speed (frequency).
   vii. Auto reset for load or voltage trip select.
   viii. Slip compensation.
   ix. Catch-A Spinning-Load select.
   x. Overload trip time set.

c. VFD Parameters:
   i. Voltage loop gain.
   ii. Voltage loop stability.
   iii. Current loop stability.

d. Controller Adjustments:
   i. PID control enable/disable.
   ii. Setpoint select.
   iii. Proportional band select.
   iv. Resent time select.
   v. Rate time select.
   vi. Input signal scaling.
   vii. Input signal select (4-20 mA/0-5 Volts).
   viii. Auto start functions: On/Off, Delay On/Off, Level Select On/Off.
   ix. Speed Profile: Entry, Exit, Pointer Select.
   x. Min, Max Speed Select.
   xi. Inverse profile select (allows VFD speed to vary directly or inversely with input signal).

2. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the present set values. This parameter log shall be accessible via a

RS232 serial port and an Ethernet IP communication port as well as on the keypad display.

P. Diagnostic Features and Fault Handling

1. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and display faults and operating conditions. Microprocessor systems must be products of the same manufacturer as the VFD (to assure single source responsibility, availability of service and access to spare parts).

2. A "FAULT LOG" shall record, store, display and print upon demand, the following for the 10 most recent events:
   a. VFD mode (Auto/Manual).
   b. Elapsed time (since previous fault).
   c. Type of fault.
   d. Reset mode (Auto/Manual).

3. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2 to 8 M/Sec. intervals for the 50 intervals immediately proceeding a fault trip:
   a. VFD mode (manual/auto/inhibited/tripped/etc.).
   b. Speed demand.
   c. VFD output frequency.
   d. Demand (output) Amps.
   e. Feedback (motor) Amps.
   f. VFD output volts.
   g. Type of fault:
      i. Br Over Current.
      ii. Br Under voltage.
      iii. Br Phase Rotation.
      iv. Br Fuse Failure.
      v. Sustained Overload.
      vi. Manual Trip Test.
      vii. Power Supply Fail.
      viii. Output Over Voltage.
      ix. Inverter Over Temperature.
      x. Thermistor Trip.
      xi. Ground Fault.

Br Over Current	Power Supply Fail
Br Under voltage	Output Over Voltage
Br Phase Rotation	Inverter Over Temperature
Br Fuse Failure	Thermistor Trip
Sustained Overload	Ground Fault
Manual Trip Test	

   h. Drive inhibit (On/Off).

4. The fault log record shall be accessible via a RS232 serial link and an Ethernet IP communications port as well as line by line on the keypad display.

Q. Communications

1. Provide each VFD with Ethernet communication module. Interface of data between the VFD and the site-wide control system shall be Ethernet IP. The connection to the VFD shall be an integral option to the VFD and shall be provided by the VFD manufacturer.

R. Drives for blowers, positive displacement pumps and other constant torque loads shall be the constant torque type, subject to supplier obtaining confirmation from the mechanical equipment manufacturer.

S. See Electrical Drawings for additional requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Install the variable speed equipment complete, including wiring installations, and conduct test for the electrical controls as indicated, specified, and required. Assure proper clearance for all equipment and materials in the layout shown on Contract Drawings.

B. Equipment shall be installed level and securely attached to the concrete floors and foundations with anchor bolts or attached to sills. The sections shall be joined together with bolts, nuts, and washers to form a complete unit assembly.

C. Wiring Installations shall be complete as indicated and specified.

D. Nameplates shall be laminated plastic and attached to clean surfaces of the metal enclosures with stainless steel screws.

E. Grounding shall be provided as shown on the Drawings, and specified in Section 16060 - Grounding and Bonding.

3.2 FACTORY TESTING

A. The VFD manufacturer shall provide the following quality assurance steps within his factory:
1. Incoming inspection of all components.
2. In-process inspection of assemblies.
3. Quality Assurance program that meets or exceeds DOD Standard Audit MIL-I-45208.
4. MIL STD-105D AWL 1% sampling.
5. MIL STD-C45662 calibration.
6. 100% test and inspection of power devices.

B. The VFD manufacturer shall provide certification that the tests have been completed.

C. The VFD printed circuit boards shall be tested at 50□C for 50 hours.

D. The completed VFD shall be operated on an unloaded motor of suitable horsepower rating.

3.3 START-UP

A. Perform sequence of operations test to assure proper function of logic, as described.

B. Site Testing of Each Variable Frequency Drive

1. Each VFD shall be functionally tested with its designated motor after installation at the site. All VFD parameters including the following shall be tested:
   a. Input Current - (2 and 3 apply).
   b. Input voltage - (2 and 3 apply).
   c. Input Frequency - (3 applies).
   d. Output Current - (2 and 3 apply).
   e. Output Voltage - (2 and 3 apply).
   f. Output Frequency - (3 applies).
   g. Acceleration Rate.
   h. Deceleration Rate.
   i. Power factor at VFD Input.
2. Each phase shall be tested.
3. Test at 15 Hz, 30 Hz, 45 Hz, and 60 Hz...
4. Miscellaneous field tests or check shall include as a minimum, the following:
   a. Check all terminations.
   b. Check grounding.
   c. Bump motor to verify rotation.
   d. Check all run lights, switches, fail lights, alarm lights, reset buttons, meters, speed potentiometers, etc.
   e. Check to determine if protective devices and features are functioning.
5. A typed and signed report of all tests and checks performed shall be provided.
6. Tests shall be performed by a representative of the VFD manufacturer.

3.4 HARMONICS TESTING OF POWER SYSTEMS

A. The harmonics analysis shall be provided by an independent firm or the manufacturer's field service division specializing in this type of analysis.

B. Testing

1. After installation of VFDs and associated equipment, the 480V power systems shall be tested for harmonics, for line notching and for RFI/EMI in cable circuits and in air.
2. Test shall be performed during normal plant operation.
3. Test shall be performed with each VFD operating at 0 Hz, 30 Hz, and 60 Hz.
4. Test shall be performed with all VFDs operating 0 Hz, 30 Hz, and 60 Hz.

C. Test Data. The following test data shall be provided for each test condition. Data shall be in the form of copies of printouts from the testing unit. Test data required is:

1. VFD output voltage for each phase of each drive.
2. VFD output current for each phase of each drive.
3. Distribution switchboard, voltage for each phase.
4. VFD input voltage for each phase (for one VFD of each size) in each location.
5. VFD input current for each phase (for one VFD of each size) in each location.
6. Isolation transformer input current for each phase (for one VFD for each size).
7. Voltage and current for each phase at the input side of the utility transformer.

D. Special Data

1. Total harmonic distortion of each current and voltage listed above shall be calculated, listed and compared to IEEE Std. 519 requirements.
2. Line notch parameters for each voltage waveform shall be calculated, listed and compared to IEEE Std. 519 requirements.
3. Measurements of EMI/RFI in air and in power cables shall be measured and listed.

E. Data submission. All test data and special data shall be submitted for review by the Engineer.

3.5 FIELD QUALITY CONTROL

A. Make the following field tests and checks after installation:

1. Check all terminations.
2. Check all grounding.
3. Verify motor rotation.
4. Check all run lights, switches, fail lights, alarm lights, reset buttons, meters, speed potentiometers, etc.
5. Check protective devices are functioning.

B. Perform system validation tests as specified in other Sections of the Contract Documents.

3.6 FIELD PAINTING

A. Touch-up field damaged factory finishes with paint that matches the original equipment finish.

3.7 TRAINING

A. After the equipment has been installed, tested, adjusted and placed in satisfactory operating conditions, provide the services of a qualified representative of the manufacturer to instruct the operating and maintenance personnel of the Owner in the use and maintenance of the equipment. Schedule the content, duration, and dates of instruction in consultation with the Owner. Include the cost of instruction in the price of the equipment.

3.8 SPARE PARTS

A. A spare parts list including original device manufacturer's part numbers for cross-referencing purposes shall be furnished. Lists containing only the VFD manufacturer's part numbers are not acceptable.

END OF SECTION

SECTION 16491
FUSES
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SECTION 16491
FUSES

PART 1. GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing labor, materials, and equipment, tools, and incidentals for complete and operable fuses.

B. This Section includes the following: Low Voltage Fuses.

C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

D. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 16010 – General Electrical Requirements.

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each fuse type specified.

C. Product Data for each fuse type specified. Include the following:
   1. Descriptive data and time-current curves.
   2. Let-through current curves for fuses with current-limiting characteristics.
   3. Fuse size for elevator feeder and disconnect applications.

D. Field test reports indicating and interpreting test results.

E. Maintenance data for indicating and interpreting test results.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are UL listed and labeled.
   1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, NEC Article 100.

D. See also Spec 16010 – General Electrical Requirements, Part 1 for listing of applicable reference standards.

1.5 SPARE PARTS

A. Furnish spare materials and parts described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Spare Fuses: Furnish Quantity equal to 20% of each fuse type and size installed, but not less than 1 set of 3 of each type and size.
   2. Fuse Holder: Furnish one fuse holder for all projects that require more than 100 fuses.
   3. Fuse Puller: Provide one fuse puller for each of the fuse sizes as necessary and recommended by the manufacturer.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Industries, Inc.; Bussman Div.
   2. ABB / GE; Wiring Devices Div.
   3. Gould Shawmut.
   4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
   5. Or accepted equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door with key-coded cam lock and pull. Mount cabinet in main electrical or mechanical room.
   1. Size: Adequate for orderly storage of spare fuses specified with 15% spare capacity minimum.

2. Finish: Gray, baked enamel.
3. Identifications: Stencil legend “SPARE FUSES” in 1-1/2-inch letters on door.
4. Fuse Pullers: For each size fuse.

PART 3. EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Main Service: Class RK1, time delay.

B. Main Feeders: Class RK1, time delay.

C. Motor Branch Circuits: Class RK1, time delay.

D. Other Branch Circuits: Class RK5, non-time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

3.4 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes lightning protection for buildings and associated structures and requirements for lightning protection system components. Unless indicated otherwise, the extent of the lightning protection system – designed, submitted for Engineer's review, furnished, installed, master labeled and documented under this Section shall include all site buildings, structures and appurtenant installations as shown.

B. Provide lightning protection system design for the following structures and equipment:

1. Utility Transformer/Generator area

2. Admin building

3. Chemical Shed

4. Treatment Basins/Blowers/Headworks area

5. Effluent Structure

6. Dewatering trailer

C. Design lightning protection system to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

D. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

E. Related Sections include, but are not limited to:

1. Section 01300 – Submittals.

2. Section 16010 – General Electrical Requirements.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.

1. Underwriters Laboratories, Inc. (UL).

a. UL 96 – Lightning Protection Components.

b. UL 96A – Installation Requirements for Lightning Protection.

2. National Fire Protection Association (NFPA).

a. NFPA 70 – National Electrical Code.

b. NFPA 780 – Lightning Protection Systems.

1.03 SUBMITTALS

A. Product Data for each component specified, in accordance with the requirements of Section 01300 - Submittals.

B. Shop Drawings detailing lightning protection system, including air terminal locations, conductor routing and connections, and bonding and grounding provision. Include indications for use of raceway and data on how concealment requirements will be met.

C. Qualification data for firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience.

D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

E. Field inspection reports indicating compliance with specified requirements.

1.04 QUALITY ASSURANCE

A. Materials and installation to conform to: NFPA 70, National Electrical Code; NFPA 780, Lightning Protection Systems; UL-96 and 96A, Lightning Protection Components and Installation Requirements for Lightning Protection System.

B. Installer Qualifications: Engage and experienced installer who is NRTL listed or who is certified by the Lightning Protection Institute as a Master Installer/Designer.

C. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.

1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.

D. Provide UL Master Label.

E. See also Spec 16010 - General Electrical Requirements, Part 1 for listing of applicable reference standards.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:

1. A-C Lightning Security, Inc.

2. Approved Lightning Protection Co., Inc.

3. Heary Bros. Lightning Protection Co.

4. Thompson Lightning Protection Co.

5. Or approved equal.

2.02 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Comply with NFPA 780, Class I or Class II as specified and / or required.

C. Hardware for Lightning Protection System: UL type and of the same material as the air terminal, or of brass or bronze, as approved for the application.

2.03 GROUND RODS

A. Copper-clad steel with a minimum of 27% of rod weight in copper cladding.

1. Diameter: 3/4-inch.

2. Length: 10-feet.

2.04 AIR TERMINALS

A. UL approved solid copper or nickel, with a diameter not less than as required per NFPA 780, having the tip as specified or indicated.

2.05 ROOF/DOWN CONDUCTORS FOR LIGHTNING PROTECTION SYSTEM

A. Copper cable meeting UL 96, with minimum size per NFPA 780, or larger as indicated.

2.06 LIGHTNING PROTECTION SYSTEM:

A. Consists of cables, air terminals, mounting bases, fittings, couplings, connectors, fasteners, and other devices for a complete, coordinated system including interconnections to ground grid.

1. Materials, except bolts, screws, and related type hardware: Copper or high-copper content bronze or nickel, or brass, and the standard product of a manufacturer regularly engaged in production of lightning protection systems. Materials shall comply in weight, size, and composition for a Class I or Class II structure to be protected in accordance with NFPA 780. Bolt, screws, and related type hardware shall be stainless steel.

2. Fittings, except cable holders: Heavy-duty type bronze casting; stamped, pressed, and crimped type pressure devices are not permitted.

3. Methods of fastening air terminals to roof: Compatible with roof composition. Do not attach copper materials to aluminum; adhesives for attaching materials to single ply membrane roofing shall be approved for use by the specific membrane-roofing manufacturer.

2.07 BOND AND WELD SEALANT

A. Vinyl-backed compound.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces, areas, and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of lightning protection. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install lightning protection as indicated, according to manufacturer’s written instructions.

B. Comply with UL 96A, LPI-175, and NFPA 780.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Where indicated, run conductors in nonmetallic raceway, Schedule 40, minimum.

D. Conceal down conductors.

E. Conceal interior conductors.

F. Provide notification at least 48 hours before concealing lightning protection components.

G. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

H. Subject to the requirements necessary for Master Labeling, install the following.

1. Bond extremities of vertical metal bodies exceeding 60-feet (18 m) in length to lightning protection components.

2. Bond ground terminals to counterpoise conductor.

3. Bond grounded metal bodies on building within 12-feet of ground to counterpoise conductor.

4. Bond grounded metal bodies on building within 12- feet of roof to counterpoise conductor.

5. Bond lightning protection components to grounded metal bodies on building at every 60-feet.

6. Bond all underground metal piping entering/ exiting the structure to the ground loop or closet ground rod.

3.03 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.04 FIELD QUALITY CONTROL

A. UL Inspection: Apply for inspection by UL as required for UL master labeling of system. Submit evidence of master labeling for record.

END OF SECTION 16670

SECTION 16960

CONTROL CIRCUITS AND PILOT DEVICES

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes furnishing, unless otherwise indicated, and installing all materials and providing all labor and supervision pertaining to control circuits and pilot devices.

B. Unless otherwise indicated, all pilot devices, such as push-button stations, selector switches, thermostats, firestats, smoke switches, pressure switches, limit switches, float switches, flow switches, pneumatic-electric switches, recorder controllers, and the like, shall be furnished by the supplier of each item or group of items of driven equipment specified in other Divisions of Contract Documents. The Contractor shall refer to the appropriate Divisions under which driven equipment, or control system applicable thereto, is to be furnished for all specific requirements which may have a bearing on work under this Section, and shall provide the proper services and other electrical work required to make the equipment operable.

C. In general, all “line” voltage (120 volts and higher) control wiring shall be provided under this Section and lower voltage wiring, such as for low voltage temperature control systems and the like, shall be furnished under the requirements of other Sections.

D. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 16010 – General Electrical Requirements.

1.02 QUALITY CRITERIA

A. Control devices shall comply with the following requirements.
   1. Underwriters Laboratories Inc. (UL).
   2. National Electrical Manufacturers Association (NEMA).
   3. National Electrical Code (NEC).

1.03 SUBMITTALS

A. Submittals shall include catalog cuts, electrical ratings, adjustment ranges, enclosure types and dimensions, necessary internal and interconnection diagrams, etc., in conformance with the requirements of Section 01300 – Submittals.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pilot devices shall generally be oil-tight, heavy-duty industrial type with adequately rated precious metal contacts and with enclosures suitable for the type and class of area and for the environment in which they are to be installed.

B. Specific requirements for pilot devices to be provided under Division 16 – Electrical, shall be as indicated on Contract Drawings or as called for under other Sections of Division 16 - Electrical.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Pilot devices and wiring thereto shall be properly supported.

B. Control circuits shall be provided and connected in accordance with diagrams indicated on the drawings and/or in accordance with diagrams to be furnished by the supplier of the driven equipment or by the supplier of the control system involved therewith.

C. All required device adjustments and settings and all required re-connections shall be provided to make all systems and equipment operate in a satisfactory manner.

END OF SECTION

SECTION 16999
ACCEPTANCE TESTING AND CALIBRATION
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SECTION 16999
ACCEPTANCE TESTING AND CALIBRATION

PART 1. GENERAL

1.1 SCOPE

A. This Section includes a Thermographic survey and the field testing, inspection and adjusting of all material and equipment installed. Other Electrical Sections covering individual types of equipment may have additional testing requirements.

B. The purpose of these specifications is to assure that all tested electrical equipment and systems are operational and within applicable standards and manufacturer's tolerances and that the equipment and systems are installed in accordance with design specifications.

1.2 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. International Electrical Testing Association (NETA).
      a. NETA – Acceptance Testing Specification.
   2. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.

1.3 QUALITY CRITERIA

A. All field testing shall conform to the latest edition of "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" as published by the International Electrical Testing Association (NETA) and shall be performed by an independent testing firm certified by NETA.

B. Items not passing test will be rejected and shall be repaired or replaced with acceptable new items.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

3.1 GENERAL

A. Inspect, test and calibrate in accord with manufacturer's instructions supplemented by this Specification.

B. Institute and maintain rigorous precautions for all test procedures requiring application of potentials above 30 volts, erect barricades around danger areas,

post suitable warning signs and station watchman as necessary to ensure that unauthorized persons do not approach energized conductors. Maintain telephone or voice radio contact between potential source location and energized remote locations during any potential testing operations.

3.2 POWER CIRCUIT BREAKERS

A. Preparatory Work: Prior to testing, remove each breaker from its compartment. Clean, lubricate, inspect and adjust each breaker in accord with manufacturer's published maintenance instructions. Inspect contacts, arc quenchers, primary and secondary disconnects, current sensors, small wiring and trip devices. Examine contacts for condition, clearance, pressure and wipe.

B. Tests and data: Determine and record the following data:
   1. Breaker identification, including Owner's designation, manufacturer's ratings, serial number, trip device type, ranges and time bands.
   2. Test each breaker electrically for proper tripping characteristics by passing 60 Hz. sinusoidal low voltage current through each pole, one at a time, with test current injection at the primary disconnects. Adjust trip devices for required pickup characteristics. Perform tests at operating trip device settings as specified. Include this information in the report plus the record of the settings "as left" after calibration.
   3. Apply sufficient current to actuate each mode of trip device, i.e., long time pickup, long time delay band, short time pickup, short time delay band, instantaneous pickup, ground pickup and ground delay band as applicable. Test current and elapsed time at tripping. For each pole, state whether or not breaker tripping is within the manufacturer's tolerances.
   4. Perform insulation resistance test on each breaker. With contacts closed, apply 1000 volts DC and make readings after one minute energization between each pair of poles and from each pole to the breaker frame.

3.3 MOLDED CASE CIRCUIT BREAKERS AND MOTOR CIRCUIT PROTECTORS (MCP).

A. Test automatic molded case circuit breakers for acceptance prior to installation in circuit. Quantity to be tested is indicated below.
   1. Thermal Magnetic Trips. (Breakers Only). Test breakers having thermal magnetic trips in a temperature controlled environment maintained at 40^{o}C plus or minus 3^{o}C. A temperature stabilization period of 15 minutes is required prior to testing the inverse-time automatic tripping characteristics. Test each pole of each breaker at 90% and 200% of its continuous current rating. Replace any breaker or trip device which trips within 10 minutes at 90%, or which fails to trip at 200% within the time indicated in the following table:

Rated Continuous Current, Amperes	Max. Tripping Time, Minutes	Breakers Tested per Panel or Switchboard
15 - 40	2	10% (NOT LESS THAN 2)
50	4	20% (NOT LESS THAN 1)
60 - 100	6	50% (NOT LESS THAN 1)
125 - 225	8	100%
250 - 400	10	100%
500 - 600	12	100%
700 - 800	14	100%
1000	16	100%
1200	18	100%

2. Instantaneous Trips. Test each pole of each breaker and motor circuit protector for automatic instantaneous tripping with slowly rising current. Replace any breaker or trip device which fails to operate within the following values:
   a. Non Adjustable Trips - plus or minus 20% of fixed setting.
   b. Adjustable Trips - plus or minus 10% of the high setting of the rms values of the instantaneous tripping current.
3. Motor Circuit Protectors after testing shall be placed in service at the minimum position which permits motor starting based on motor nameplate data following MCP manufacturer's instructions.

3.4 MOTORS AND MOTOR CONTROLS

A. Inspect and test motors and motor wiring, power and control for proper connection, circuit continuity, wire identification, insulation resistance and proper functioning or operation. Test insulation resistance from line to line and from each line to ground with a test instrument. Make tests prior to energizing circuits. Test motors for correct rotation. Test proper operation of starters and control devices. Record the nameplate data of motors for the selection of the proper overload relay heater size. Overload relay heaters furnished with equipment shall not be considered correct by virtue of the fact that heaters were so furnished and installed.

B. Test and inspect power distribution equipment for damage, defects and for proper functioning of all electrical and mechanical components. Test line and load bus, connections and conductors for test circuit breakers for proper electrical and mechanical operation.

C. Place motor circuit protectors in service at the minimum position which permits motor starting, based on motor nameplate data and following MCP manufacturer's instructions.

3.5 SPECIAL SYSTEMS

A. Exercise care in the testing of electrical systems so as not to damage special, electronic or instrumented circuits. Do not undertake to check or test special electronic or instrumented circuits beyond the manufacturer's instructions included with the equipment and performed for equipment installation. Test the continuity only for alarm, instrumentation, or similar special wiring systems prior to the final equipment connections.

3.6 INSULATION TESTS

A. Furnish the necessary test equipment and labor to test the insulation of electrical equipment and circuits before they are energized. Use a 500 volt "Megger" or other accepted instrument, to test the insulation resistance of circuits insulated for 600 volts, associated motors and transformers, low-voltage motor control centers and low voltage switchboard.

B. Insulation Tests: Include, but are not limited to, the following:
   1. Transformers: Test primary to ground, secondary to ground and primary to secondary.
   2. Services: Test phase to phase and each phase to ground.
   3. Cables: Test phase to phase and each phase to ground.
   4. Motors: Test winding to ground.
   5. Load Side of 600 Volt Circuits: Test each phase to ground and phase to phase.
   6. Maximum Acceptable Megger Readings (Megohms at 20 C) for 600 volt class equipment:

a. Transformers	Megohms
b. Primary to ground	20
c. Primary to Secondary	20
d. Secondary to Ground	5
e. Services - Motor Starters and Buses	20
f. Motors	1
g. Load side of 600 volt circuits less motor	20

C. Control power transformers, potential transformers and other devices connected phase to phase or phase to ground and any devices not designed to withstand the test voltages must be disconnected when testing insulation resistance in switchboard, motor control centers and other apparatus.

D. Keep written record of tests performed on forms accepted for the purpose and turned over to Owner upon request, or at the termination of the Work. Identify each circuit or piece of apparatus tested, the date of the test, the temperature at the

time of testing, the instrument used, the test voltage applied, the resistance values found and the name of the person in charge of and witnessing the test.

3.7 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection
   1. Inspect physical, electrical, and mechanical condition.
   2. Remove all necessary covers prior to thermographic inspection. Utilize appropriate caution, safety devices, and personal protective equipment.

B. Equipment to be inspected shall include MCCs, switchboards, transformers and panelboards.

C. Provide report including the following:
   1. Description of equipment to be tested.
   2. Discrepancies.
   3. Temperature difference between the area of concern and the reference area.
   4. Probable cause of temperature difference.
   5. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
   6. Identify load conditions at time of inspection.
   7. Recommended action.

D. Test Parameters
   1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
   2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Refer to NFPA 70B, Section 18-16 (Infrared Inspection).

E. Test Values
   1. Suggested actions based on temperature rise can be found in Table 10.18 of NETA Acceptance Testing specifications.

3.8 FINAL INSPECTION AND TEST

A. Upon completion of the various phases of the project, or at convenient times during progress of the Work, check and/or test as herein specified all equipment and wire installed.

B. Under no circumstances shall any part of the installation be operated by construction personnel without prior written acceptance of the Engineer. This restriction includes the checking of electrical motors for rotation.

C. Upon receipt of written notice that the work has been completed, including tests herein specified, Engineer will give the entire Work a thorough inspection. Any defects or omissions noted shall be corrected before acceptance of the work.

D. The inspections and tests to be made shall include, but are not limited to, the following:
   1. Visually inspect wires and cable connections including internal wiring of switchgear, transformers and other equipment.
   2. Verify continuity of power and control conductors.
   3. Make insulation tests as herein specified.
   4. Check control circuits for short circuits and extraneous grounds.
   5. Check equipment for proper mechanical adjustment and freedom of operation and removal of shipping blocks and/or stops.
   6. Check closing, tripping, supervision and alarm functions of the controlled equipment.
   7. Operate motor controllers, contactors, etc., from their control devices.
   8. Check operation of alarm circuits.
   9. Check motors for proper rotation and motor currents measured under load conditions. Any motor found to be operating incorrectly shall be inspected to determine the cause and the condition shall be corrected to the satisfaction of the Engineer. Furnish a record of these tests to the Engineer.

END OF SECTION